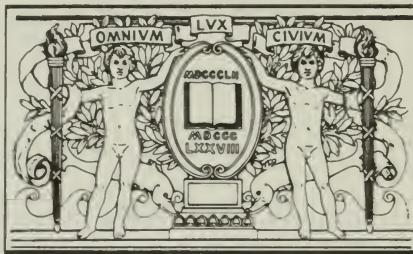


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# The Commonwealth of Massachusetts

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## Resolves of 1938, Chapter 39

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RESOLVE RELATIVE TO THE METHOD OF ENGRAVEMENT BY THE STATE SECRETARY OF A BILL ENTITLED "AN ACT FOR CODIFICATION, REVISION AND AMENDMENT OF THE LAWS RELATIVE TO THE CONSTRUCTION, ALTERATION AND MAINTENANCE OF BUILDINGS AND OTHER STRUCTURES IN THE CITY OF BOSTON", AND TO THE PRINTING AND PUBLICATION OF SUCH BILL UPON ITS BECOMING LAW.

*Resolved*, That the state secretary is hereby authorized and directed to prepare for enactment by the general court an exact copy of the bill of the current year entitled "An Act for Codification, Revision and Amendment of the Laws relative to the Construction, Alteration and Maintenance of Buildings and other Structures in the City of Boston", as passed to be engrossed by both branches, so far as possible by pasting a printed copy of said bill, as so passed, on the kind and size of paper specified in section twenty-three of chapter three of the General Laws, and the copy so prepared shall be deemed to have been fairly engrossed in compliance with said section twenty-three; and be it further

*Resolved*, That, notwithstanding the provisions of sections two, three and four of chapter five of the General Laws, the state secretary shall not cause said bill, as enacted into law, to be printed and published, as provided in said sections, but shall print in the publications provided for by said sections, under the chapter number of said bill as enacted, its title, the date when it becomes law and an appropriate reference to this resolve; and he shall cause five hundred copies of said bill, as enacted, to be printed and published separately in such form as he may determine. He shall distribute the same in such manner as he may determine. Copies of said act so separately printed and published shall have the same force and effect as though printed and published in accordance with said sections.

*Approved June 7, 1938.*



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# The Commonwealth of Massachusetts

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## Acts of 1938, Chapter 479

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AN ACT FOR CODIFICATION, REVISION AND AMENDMENT  
OF THE LAWS RELATIVE TO THE CONSTRUCTION, ALTER-  
ATION AND MAINTENANCE OF BUILDINGS AND OTHER  
STRUCTURES IN THE CITY OF BOSTON.

*Be it enacted by the Senate and House of Representa-  
tives in General Court assembled, and by the  
authority of the same, as follows:*

### PART 1.

#### ADMINISTRATION.

##### SECTION

- 101 — Title.
- 102 — Repeals.
- 103 — Pending Actions.
- 104 — Other Statutes.
- 105 — Effective Date.
- 106 — Definitions.
- 107 — Scope.
- 108 — Maintenance.
- 109 — Organization.
- 110 — Application for Permit.
- 111 — Permits.
- 112 — Fees.
- 113 — Inspection.
- 114 — Posting Floor Loads.
- 115 — Annual Report.
- 116 — Powers and Duties of Building Commissioner.
- 117 — Board of Appeal.
- 118 — Appeals.
- 119 — Decisions of the Board of Appeal.
- 120 — Board of Examiners.
- 121 — Board of Examiners of Gas Fitters.

## SECTION

- 122 — Penalties.
- 123 — Enforcement Jurisdiction.
- 124 — Classification of Buildings by Types of Construction.
- 125 — Types of Construction.
- 126 — Type I, Fireproof Construction.
- 127 — Type II, Semi-Fireproof Construction.
- 128 — Type III, Heavy Timber and Masonry Construction.
- 129 — Type IV, Light Wood and Masonry Construction.
- 130 — Type V, Metal Frame Construction.
- 131 — Type VI, Wooden Frame Construction.
- 132 — Occupancies Classified.
- 133 — Change of Occupancy.
- 134 — Multiple Occupancies.
- 135 — Elevators and Escalators.
- 136 — Building Height.

SECTION 101. *Title.* — This act shall be known and may be cited as the Boston Building Code and is hereinafter referred to as this code.

SECTION 102. *Repeals.* — Except as provided in section one hundred and three, the following acts and parts of acts, as severally amended, are hereby repealed; — chapter two hundred and sixty-five of the acts of eighteen hundred and ninety-seven; the two paragraphs added to section four of chapter three hundred and eighty-three of the acts of nineteen hundred and five by section one of chapter one hundred and fifty-six of the Special Acts of nineteen hundred and nineteen; chapter five hundred and fifty of the acts of nineteen hundred and seven, except section one hundred and twenty-eight thereof; chapter three hundred and forty-two of the acts of nineteen hundred and eleven; chapter seven hundred and twenty-nine of the acts of nineteen hundred and thirteen; chapter seven hundred and eighty-two of the acts of nineteen hundred and

fourteen; sections one to five, inclusive, of chapter one hundred and sixty-three of the Special Acts of nineteen hundred and nineteen; chapter two hundred and seventy-eight of the acts of nineteen hundred and twenty-three; chapter one hundred and eighty-two of the acts of nineteen hundred and twenty-six; and chapter forty-two of the acts of nineteen hundred and twenty-seven.

SECTION 103. *Pending Actions.* — All actions and proceedings, at law or in equity, and all prosecutions, pending on the effective date of this code, whether commenced for the purpose of enforcing any of the provisions of the acts, or parts thereof, repealed by the preceding section or brought upon any complaint or indictment for the violation of any of such provisions, or for the violation of any ordinance, rule or regulation established thereunder for the violation of which a penalty of a fine or imprisonment, or otherwise, is provided therein, may be prosecuted and enforced to the same extent as if said acts, or parts thereof, were still in force and effect.

SECTION 104. *Other Statutes.* — All statutes applicable generally to departments of the city of Boston, including the provisions of section five of chapter four hundred and eighty-six of the acts of nineteen hundred and nine, as most recently amended by chapter two hundred and twenty-seven of the acts of nineteen hundred and thirty-four, and any pertinent action taken thereunder whether before or after the effective date of this code, shall apply to the building department and to the boards established under sections one hundred and nine, one

hundred and seventeen, one hundred and twenty and one hundred and twenty-one hereof.

SECTION 105. *Effective Date.* — This code shall take full effect upon its acceptance by vote of the city council of the city of Boston, subject to the provisions of its charter. If an application for a permit, as provided in section one hundred and ten, is filed before said effective date, and a permit is issued thereon and the work is actually commenced within ninety days after the issuance of the permit, the applicant notwithstanding any provision to the contrary in section one hundred and seven, may elect to be governed in the entire operation covered by the permit either by the building laws as they existed when the application was filed or by this code.

SECTION 106. *Definitions.* — (a) For the purposes of this code the words and phrases defined in this section shall be construed as so defined except when qualifying words or the context clearly indicate that another meaning is intended.

“Abut”, touch, be contiguous. A building abuts upon a street when some part of the building touches or extends to the line of the street. A building shall be construed to abut upon a street if it is nearer at any point than ten feet from the street or when the space between the building and the side line of the street is used wholly or chiefly for the purposes of a street or sidewalk.

“Apartment”, a room or suite of rooms occupied by one person or one family for living and sleeping purposes.

“Apartment hotel”, a building containing four or more apartments without kitchens, primarily for persons who have their residences therein.

“Apartment house”, a building containing four or more apartments with kitchens, primarily for persons who have their residences therein.

“Approved”, approved by the building commissioner of the city of Boston.

“Area of a building, fire division or unit of occupancy”, the maximum horizontal projected area of the building above ground or of the fire division or unit of occupancy, respectively, including covered porches but excluding terraces, steps, cornices, fire escapes and exterior stairways or ramps.

“Assembly hall”, a hall or room, including the balconies thereof, if any, in which persons may assemble.

“Attic”, the space, generally unfinished, above the ceiling of the top story of a building and below the roof, usually steeply sloping, where the maximum height may exceed six feet, provided said space is not occupied by persons. An attic shall not be counted as a story.

“Auditorium”, an assembly hall in which persons may assemble to hear or see concerts, plays, lectures or similar performances.

“Automatic sprinklers”, a system of piping supplied with water under pressure with devices for releasing under the influence of heat and spraying the water on ceilings, walls and floors.

“Balcony”, in an auditorium, a balcony, gallery or mezzanine; a floor, inclined or level, above the main floor, not enclosed on one or more sides other than by a railing. Where a balcony of an audito-

rium has exits at two or more levels opening into separate foyers, one above another, each portion thereof served by such a foyer shall be considered a separate balcony for the purpose of this code.

“Basement”, a story of a building below the first story.

“Building”, a structure forming a shelter for persons, animals or property, and having a roof. The word “building” shall be construed, where the context allows, as though followed by the words “or part thereof”.

“Building, area of”, the maximum horizontal projected area of a building, above ground, including exterior walls one or more of which may be party walls and including covered porches but excluding terraces, steps and cornices.

“Building, height of”. In linear measure, the vertical distance of the highest point of the roof, excluding pent houses and roof structures, above the mean grade of the sidewalk at the line of the street or streets on which the building abuts; and, if the building does not abut on a street, above the mean grade of the ground around and contiguous to the building; and provided, further, that the grade of the ground contiguous to a building shall not be considered for the purpose of this definition to be above or below the grade of the ground at any point distant not over twenty feet from the building by more than half that distance. In stories, the number of stories above the floor of the first story.

“Building, existing”, a building already erected on the effective date of this code, or thereafter erected, as provided in section one hundred and five, under permit for its construction subject to

the provisions of law in effect prior to such effective date.

“Building, new”, a building erected after the effective date of this code and subject to the provisions thereof.

“Bulkhead”, the raised portion of a floor or roof, raised for the passage of persons, materials, light or air, through the side of such raised portion, or for other purpose.

“Cellar”, see basement.

“Chimney”, a vertical structure of masonry with one or more flues in which smoke or the products of combustion are conducted upward for disposal in the open air at a height above the ground.

“Code”, “this code”, the Boston Building Code, consisting of this act and the regulations established thereunder.

“Commissioner”, the building commissioner of the city of Boston.

“Corridor”, an enclosed passageway.

“Dead load”, the weight of materials built into the construction of a building including walls, permanent partitions, floors, roofs, framing and all other permanent stationary construction entering into and becoming part of a building.

“Department”, the building department of the city of Boston.

“Exit”, a means of egress; a way out.

“Exit from a room”, a doorway or other means of egress from the room on the way toward an exit from the building.

“Exit from a story”, a stairway, ramp, ladder or other means of egress from the story on the way toward an exit from the building.

“Exit from a building”, a doorway or other means of egress from the building opening upon a street or upon an open space with unobstructed access to a street.

“Exit, path of”, the continuous series of doorways, connecting rooms, corridors, passages, stairways, ramps and the like, which leads from any exit from a room through an exit from the building to a public street.

“Family”, a group of persons living together who share at least in part their living quarters and accommodations.

“Fire division”, a portion of a building so well separated from the rest by separations as specified in Part 13, that it may be erected to the maximum height and area allowed for its principal occupancy and type of construction, independently of adjoining occupancies. A portion of a building separated from the rest by fire walls.

“Fire door”, a door of fire-resistive construction as specified in Part 22.

“Fire extinguisher”, a portable device for extinguishing a fire.

“First aid hose station”, a hose connection with valve in a system of piping adequately supplied with water, hose and nozzle for use of occupants of a building in extinguishing a fire.

“Floor area”, of a room, the area of the floor contained within the walls; of a building or fire division, the area thereof, including exterior walls, at the given floor level.

“Foundation”, that portion of a building or structure of which the sole or chief purpose or use is to transmit the weight of the building or structure to

the earth; the support of the lowest portions of columns, walls, piers or other vertical members.

“Foundation wall”, a foundation in the form of a wall; that portion of the exterior wall of a building used as a foundation which is below the grade or adjoining ground.

“Foyer”, a foyer, lobby, corridor or passage, one or more in combination, adjacent to the auditorium of a theatre or assembly hall at the level of the main floor or a balcony thereof and into which one or more exits therefrom open, in the path of normal egress from the building.

“Front”, a building or wall fronts upon a street when a wall of the building or the wall faces the street and is parallel thereto or makes an angle of less than forty-five degrees therewith.

“Fusible link”, a device consisting of two pieces of brass or other suitable metal connected by solder or other metal fusible at a moderate temperature, arranged to release in the presence of fire or excessive heat; or any equivalent approved device.

“Gage”, for sheet metal, United States Standard Gage; for brass and copper tubing, Stubs Gage; for wire, Washburn & Moen or Roebling Steel wire gage.

“Garage”, a building or portion thereof in which is housed or stored one or more motor vehicles containing or using a volatile flammable fluid for fuel or power, or in which such motor vehicles are painted, repaired or serviced.

“Gasfitting”, the art of installing, repairing or altering pipes, fittings, fixtures and other apparatus for distributing gas for heat, light, power or other purposes; the system of pipes, fittings, fixtures

and other apparatus for distributing gas for heat, light, power or other purposes.

“Grade”, elevation with reference to Boston city base, namely, a horizontal plane of reference established and used by the city of Boston.

“Grade, mean”, the average of the grades of mid-points of successive equal distances of not over ten feet measured along the line or lines along which the mean grade is to be determined.

“Hotel”, a building containing four or more apartments without kitchens, or sleeping accommodations for ten or more persons, primarily the temporary abode of persons who have their residences elsewhere.

“Kitchen”, a room used or adapted for cooking and containing a stove, range, hot-plate or other cooking apparatus, which burns coal, oil, gas or other fuel or is heated by electricity, except electric appliances consuming less than eighteen hundred watts.

“Lintel”, a beam in a masonry wall supporting the masonry above an opening.

“Live load”, the load or weight to be supported on floors or other portions of buildings incidental to their occupancy; the pressure of wind, the weight of snow, and all loads other than dead loads.

“Masonry”, construction of assembled units of stone, brick, concrete, gypsum or other similar incombustible materials separated from one another and held in place by mortar.

“Masonry, dry”, masonry, except that the units are not separated or held in place by mortar.

“May”, a term giving permission but not, except

in the negative, making a requirement. "May" is used in this code to emphasize that specified construction is not prohibited by the code when such prohibition might otherwise be implied or construed; or to limit the scope of a prohibition by excepting specified construction from its effect. A permission so expressed in this code in specific terms shall not be construed as a prohibition of other construction. "May not" is prohibitive.

"Mezzanine floor", a floor within a story between the floor and ceiling thereof, having an area not over forty per cent of the area of the building at the level at which the mezzanine floor occurs. A floor of larger area separates two stories.

"Non-corrodible metal", a metal which, under the conditions of its use, may reasonably be expected, without unusual or excessive maintenance, to serve its purpose throughout the probable life of the structure in which it is used, as determined by the commissioner.

"Occupancy", use or occupancy of a building, character of use, or designated purpose of a building or structure or portion thereof.

"Occupancy, unit of", that portion of one building within separations within which the occupancy, whether of one or more tenants, falls in a single group and division as classified in section one hundred and thirty-two and Parts 3 to 12, inclusive, of this code.

"Or", providing an alternative at the option, unless the contrary is clearly indicated, of the applicant for a permit.

"Owner", the owner of the land as recorded in

the registry of deeds for Suffolk county, or as registered in the land court, except as otherwise provided in paragraph (d) of this section.

“Partition”, see Wall.

“Passageway”, a continuous way, of required width, kept clear for use as an exit, whether enclosed or not.

“Pier”, a vertical body of masonry used as a column, the portion of a masonry wall between thinner portions or between openings when the horizontal dimension parallel to the wall does not exceed four times the thickness.

“Plumbing”, the art of installing, repairing or altering the pipes, fixtures and other apparatus for distributing the water supply and removing liquid and water-carried wastes; the system of pipes, fixtures and other apparatus installed in buildings for distributing the water supply and for the disposal of liquid and water-carried wastes, including valves, traps and soil, waste and vent pipes; provided, that nothing herein contained shall include the work of steamfitting.

“Projection room”, a room in a theatre or assembly hall containing a projector of moving pictures.

“Remote”, in reference to two or more exits, removed or distant from one another in such manner that a person in any place served by such exits may choose either of two directions in a path toward an exit and in such manner that a single fire could not, in its early stages, block both paths toward an exit.

“Seating capacity”, the number of seats within an auditorium or other hall when fastened to the floor;

the number of persons who may be seated within an auditorium or hall allowing six square feet of floor area per person unless fixed seats are provided.

“Separation”, a system of walls, floors or other construction serving to separate or cut off one unit of occupancy from another.

“Shaft”, an enclosure of a vertical opening in two or more stories.

“Smoke pipe”, a flue, approximately horizontal, of metal or other material, in which smoke or the products of combustion are conducted from a furnace to a chimney or stack.

“Smoke stack”, a vertical flue of metal or reinforced concrete, whether or not lined with masonry or other protective material, in which smoke, or the products of combustion, are conducted upward for disposal in the open air at a height above the ground.

“Soil”, the softer matter mostly inorganic composing part of the surface of the earth in distinction from the firm rock; including gravel, clay, loam and the like, and filling materials of similar nature.

“Sprinklers, automatic”, a system of automatic sprinklers installed in accordance with this code.

“Stair, rise of”, the vertical distance between successive treads or steps measured always from the same relative position thereon.

“Stair, tread of”, the horizontal distance from one riser to the next or from one nosing to the next. “Story”, that portion of a building included between the top surface of a floor and the top surface of the next floor or roof above, except that a space used exclusively for the housing of mechanical services of the building shall not be considered to be a

story if access to such space may be had only for maintenance of such services.

“Story, first”, the lowest story of which sixty-five per cent or more of the height is above the mean grade from which the height of the building is measured.

“Structure”, a combination of materials assembled at a fixed location to give support or shelter, such as a building, bridge, trestle, tower, framework, retaining wall, tank, tunnel, tent, stadium, reviewing stand, platform, bin, fence, sign, flag-pole or the like. The word “structure” shall be construed, where the context allows, as though followed by the words “or part thereof”.

“Unit of occupancy”, see “Occupancy, unit of”.

“Unit of occupancy, area of”, the maximum horizontal projected area of a unit of occupancy.

“Vertical opening”, an opening in a floor or roof for giving access vertically from the story below or above for light, ventilation, the movement of persons or materials or for any other purpose.

“Wall, bearing”, a wall which supports a floor, roof or other vertical load in addition to its own weight.

“Wall, curtain”, an exterior, non-bearing wall more than one story high and not supported at each floor level, which is laterally stayed by masonry piers or by the frame of the building.

“Wall, enclosure”, an interior wall, bearing or non-bearing, which encloses a stairway, elevator shaft or other vertical opening.

“Wall, fire”, a wall separating two fire divisions of a building.

“Wall, non-bearing”, a wall which supports no vertical load other than its own weight.

“Wall, panel”, a non-bearing exterior wall not over one story high, or supported at each floor level.

“Wall, parapet”, a wall or part of a wall above the roof of a building.

“Wall, partition”, an interior bearing or non-bearing wall, not over one story in height the chief function of which is to separate two rooms.

“Wall, party”, a wall used or adapted for use in common as a part of two buildings.

“Wall, retaining”, a wall used to resist the lateral displacement of liquid, granular or other materials.

(b) In conformity with the purposes of this code, to prescribe the minimum requirements for structures and the maximum utility of structures consonant with safety, the phrases “at least”, “not less than” or “not more than” shall be construed to precede quantitative specifications, as determined by the commissioner.

(c) Wherever in this code a public official is referred to by the title of his office without mention of any municipality, unless the context otherwise requires, such reference shall be to an official of the city of Boston.

(d) Nothing in this code shall be held to prevent the owner of land from transferring to another his rights and responsibilities under this code by means of a lease or other suitable agreement. The commissioner may recognize the person to whom such a transfer by operation of law or otherwise has been made as the possessor of such rights and responsibilities and to such extent as the owner in receiving

applications, issuing permits and otherwise in enforcing this code.

**SECTION 107. Scope.** — (a) The provisions of this code shall apply to every building or structure hereafter erected in the city of Boston, except public highway, railroad or railway bridges or trestles, quays or wharves, buildings owned and occupied by the United States or the commonwealth, railroad structures and stations used primarily for railroad purposes, subway and elevated railway structures and stations used primarily for railway purposes, voting booths erected and maintained by the board of election commissioners, prefabricated metal tanks of less than five thousand gallons capacity and tanks exceeding ten thousand gallons capacity for liquids other than water, tunnels constructed and maintained by a public authority, tents covering an area less than one hundred square feet, fences less than six feet high, signs or billboards upon the ground and signs less than one square foot in area, upon or attached to the outside of a structure and flagpoles less than twenty feet in length.

(b) The provisions of sections one hundred and eight, one hundred and fourteen, one hundred and sixteen, one hundred and eighteen, one hundred and nineteen, one hundred and twenty-two, and one hundred and twenty-three shall apply to existing buildings.

(c) An existing building may be altered, repaired, enlarged, moved, or converted to other uses, only in conformity with the following provisions of this section and subject to permit as hereinafter provided.

(d) An existing building which is altered or re-

paired within any period of twelve months, said alterations or repairs costing in excess of fifty per cent of its physical value, shall be made to conform to the requirements of this code for new buildings. An existing building damaged by fire or otherwise in excess of fifty per cent of its physical value before such damage shall be made to conform to such requirements, if repaired. If the cost of such alterations or repairs or the amount of such damage is more than twenty-five but not more than fifty per cent of the physical value of the building it shall be made to conform to such requirements in the portions so altered or repaired to such extent as the commissioner may determine, except buildings of Group I, Division 1, of Type VI construction. For the purposes of this section physical value shall be determined by the commissioner.

(e) An existing building of which the occupancy is entirely changed to an occupancy with the requirements for which in this code such building does not conform shall be made to conform unless the change in occupancy will not, in the opinion of the commissioner, enlarge or increase the non-conformity or hazard of such building; provided, that if the occupancy of only a portion of an existing building is so changed and that portion is separated from the remainder as specified in Part 13 of this code, then only such portion need be made so to conform.

(f) An existing building which is enlarged in floor area or in number of stories shall be made to conform throughout the entire building to the requirements of this code in respect to egress and fire protection.

(g) An existing building to which repairs and alterations are made which are not covered by the

preceding paragraphs of this section, may be repaired or altered with the same kind of materials as those of which the building is constructed, providing such alterations or repairs will not increase an existing non-conformity or hazard; but not more than twenty-five per cent of the roof covering of a building shall be replaced in any period of twelve months unless the entire roof covering is made to conform with the requirements of this code for new buildings. New roofing meeting the requirements of this code may be placed over existing roofing providing that it be properly supported and securely fastened.

(h) An existing building when moved to another location shall conform to the requirements of this code relative to the fire limits, to location on the lot and to exterior walls.

(i) Except as otherwise provided in this section, no provision of this code shall be held to deprive the health department, the police commissioner, the board of street commissioners, the licensing board, the fire commissioner or the park department of the city of Boston either of any power or authority which it, he or they had on the effective date of this act or of any remedy then existing for the enforcement of its, his or their orders.

(j) Provisions of this code relating to buildings shall also apply to structures other than buildings to such extent as they are pertinent.

SECTION 108. *Maintenance.*—All buildings or structures, and all parts thereof, shall be maintained in a safe condition. All devices or safeguards which are required by this code in a building when erected, altered or repaired, shall be maintained in good work-

ing order, except as otherwise provided in section twenty-seven A of chapter one hundred and forty-eight of the General Laws. Except as otherwise provided in paragraph (d) of section one hundred and six, the owner shall be responsible for the maintenance of all buildings and structures. This section shall apply to existing as well as to new buildings.

SECTION 109. *Organization.*—(a) There is hereby established in the city of Boston a department to be called the building department, which shall be in charge of the building commissioner.

(b) The commissioner shall have had at least ten years' experience as an architect, builder or civil engineer, and shall be appointed by the mayor for a term of five years. He shall receive such salary as shall be fixed by the city council, with the approval of the mayor.

(c) Upon the effective date of this code the building commissioner of the building department, as constituted immediately prior thereto, shall become the building commissioner of the building department established by paragraph (a) of this section, the members of the board of appeal, as constituted immediately prior thereto, shall become the members of the board of appeal established by paragraph (a) of section one hundred and seventeen, the members of the board of examiners, as constituted immediately prior thereto, shall become the members of the board of examiners established by paragraph (a) of section one hundred and twenty, and the licensed master gasfitter member of the board of examiners of gasfitters, as constituted immediately prior thereto, shall become the licensed master gasfitter member

of the board of examiners of gasfitters established by paragraph (a) of section one hundred and twenty-one, and each of said persons shall thereafter hold his respective position until the expiration of such period of time as shall be equal to the remainder of the term for which he was appointed, unless sooner removed or discharged according to law; and all of the employees of the building department, as constituted immediately prior thereto, who are subject to the civil service laws shall be reappointed to similar positions in the building department or the several boards established by this code with the same status and compensation held and received by them, respectively, immediately prior thereto in the building department and the several boards established by this code, without civil service examination or registration; and the said building commissioner, and all such employees upon such reappointment, shall retain all rights to retirement with pension that shall have accrued or would thereafter accrue to them, and their services shall be deemed to have been continuous to the same extent as if this code had not been passed.

(d) The commissioner, with the approval of the mayor, may appoint such number of officers, inspectors, assistants and other employees as the city council shall from time to time determine. No person shall be appointed as inspector of construction who has not had at least five years' experience as a builder, civil engineer or architect, or as a superintendent, foreman or competent mechanic in charge of construction.

(e) The commissioner may appoint as his deputy an officer or other employee in the department who

shall, during the absence or disability of the commissioner, exercise all the powers of the commissioner.

(f) No officer or employee connected with the department, except one whose only connection is as a member of a board, shall be financially interested in furnishing of labor, material or appliances for the construction, alteration or maintenance of a building, or in the making of plans or of specifications therefor, unless he is the owner of such building. No such officer or employee shall engage in any work which is inconsistent with his duties or with the interests of the department. The provisions of this paragraph shall not apply to the members of boards established by this code.

(g) The commissioner shall keep a record of the business of the department. The records of the department shall be open to public inspection. The commissioner shall not, however, be required to allow inspection of the plans of buildings except upon request of the owner. If such request is made more than two months after completion of the work described in the plans, the commissioner shall allow such inspection only upon payment of such fee as the commissioner, with the approval of the mayor, may establish.

SECTION 110. *Application for Permit.* — (a) Whoever desires in the city of Boston to erect, enlarge, alter, substantially repair, move, demolish or change the occupancy of a building or structure, or to install, alter or substantially repair plumbing, gasfitting, fire extinguishing apparatus or elevators, or to install a steam boiler, furnace, heater, or other heat producing apparatus the installation of which is regulated by

this code, engine or dynamo, or to cause any such work to be done, shall first make application to the building commissioner and obtain a permit therefor.

(b) Each application for a permit with the required fee shall be filed with the commissioner on a form furnished by him and shall contain a general description of the proposed work and its location. It shall be signed by the owner or his authorized agent, and before a permit is issued such application shall also be signed by the person who is to perform or take charge of the work covered by such permit.

(c) Each application hereunder shall indicate the proposed occupancy of all parts of the building and of that portion of the lot, if any, not covered by the building, and shall contain such other information as may be required by the commissioner.

(d) The commissioner may require the material facts contained in each such application to be certified by the applicant under oath.

(e) When required by the commissioner, copies of plans drawn with sufficient clarity and detail to indicate the nature and character of the work shall accompany every such application, and shall be filed in duplicate with the commissioner. Such plans shall contain information, in the form of notes or otherwise, as to the quality of materials where quality is essential to conformity with this code. Such information shall be specific, and this code shall not be cited as a whole or in part, nor shall the term "legal" or its equivalent be used, as a substitute for specific information.

(f) The commissioner may require details, computations, stress diagrams and other data necessary to describe the construction and basis of calcula-

tions. He may also require plans showing the location of the proposed building and of every existing building on the lot. He may require structural plans and computations to bear the signature of the architect or engineer in charge of the structural design, and plot plans to bear the signature of an approved surveyor.

(g) An application for a permit for any proposed work shall be deemed to have been abandoned six months after the date of filing, unless within such time a permit shall have been issued; provided, that for cause one or more extensions of time for periods of not exceeding ninety days each may be allowed in writing by the commissioner.

(h) The commissioner shall examine each application for permit and the plans and computations filed therewith and shall ascertain by such examination with or without affidavit of the architect or engineer who has signed the plans and computations, or otherwise, whether the construction indicated and described is in accordance with the requirements of this code and of all other pertinent laws or ordinances.

SECTION 111. *Permits.* — (a) If the commissioner is satisfied that the work described in an application for permit conforms to the requirements of this code and other pertinent laws and ordinances, and if the person designated by signature on the application as the person who will perform or take charge of the work is duly licensed, the commissioner shall issue a permit therefor to the applicant; provided, that if the work to be done, in the opinion of the commissioner, is of minor importance, and of

such simple character that its execution by an un-licensed person will not endanger the public or any workman engaged thereon, the commissioner need not require the signature to be that of a licensed person but may issue the permit applied for after entering upon the application his reason for waiving such requirement.

(b) If the application for a permit and the plans filed therewith describe work which does not conform to the requirements of this code or other pertinent laws or ordinances, the commissioner shall not issue a permit, but shall return the plans to the applicant with his refusal to issue such permit. Such refusal when requested shall be in writing and shall contain the reasons therefor.

(c) Permits for ordinary repairs, for minor alterations not involving vital structural changes, and for small buildings, may be issued upon presentation of an application on a special form, to be furnished by the commissioner, and payment of the required fee.

(d) When application for permit to erect or enlarge a building has been filed, and pending issuance of such permit, the commissioner may, in his discretion, upon payment of the required fee, issue a special permit for the foundations of such building. The holder of such a special permit shall proceed only at his own risk and without assurance that a permit for the superstructure will be granted.

(e) The commissioner shall act upon an application for a permit with plans as filed, or as amended, without unreasonable or unnecessary delay. A permit issued shall be construed to be a license to proceed with the work and shall not be construed as authority to violate, cancel, alter or set aside any

of the provisions of this code, nor shall such issuance of a permit prevent the commissioner from thereafter requiring correction of errors in plans or in construction or of violations of this code. Any permit issued shall become invalid unless the work authorized by it shall have been commenced within six months after its issuance; provided, that for cause one or more extensions of time, for periods not exceeding ninety days each, may be allowed in writing by the commissioner.

(f) When the commissioner issues a permit he shall endorse in writing, or stamp, both sets of plans "Approved". One set of plans so approved shall be retained by the commissioner and the other set shall be returned to the applicant, shall be kept at the site of work and shall be open to inspection at all reasonable times by the commissioner or his authorized representative.

(g) An architect, engineer or builder who is preparing plans for a building or structure in the city of Boston may make written request of the commissioner for an interpretation of this code as specifically applicable to such building or structure. The request shall be made on a form furnished by the commissioner, shall indicate the specific provision of this code as to which interpretation is so desired, shall be accompanied by the required fee, and shall contain or be accompanied by a description of the proposed work with plans sufficient to enable the commissioner to form an opinion. The commissioner shall make reply in writing within thirty days after receipt of the request either that the description of the proposed work is inadequate to form the basis of an opinion, or that he discerns no reason under

the indicated provision of this code for disallowing the proposed construction, or that his interpretation of such provision will not allow the proposed construction for reasons which he shall state. If the commissioner shall interpret such provision as not allowing the proposed construction, such interpretation shall be deemed a disallowance thereof and any person deeming himself aggrieved thereby may appeal from such disallowance as provided in section one hundred and eighteen.

(h) Whenever a permit is to be issued in reliance upon an affidavit as provided in paragraph (h) of section one hundred and ten or whenever the work to be covered by a permit involves construction under conditions which, in the opinion of the commissioner, are hazardous or complex, the commissioner shall require that the architect or engineer who signed the affidavit or made the plans or computations shall supervise such work, be responsible for its conformity with the approved plans, and forthwith upon its completion make and file with the commissioner written affidavit that the work has been done in conformity with the approved plans and with the structural provisions of this code. In the event that such architect or engineer is not available a competent person whose qualifications are approved by the commissioner shall be employed by the owner in his stead.

SECTION 112. *Fees.* — (a) Whoever applies for a permit shall pay, at the time of filing his application, the fee established under authority of chapter two hundred and ninety-seven of the acts of nineteen hundred and thirty-one.

(b) The commissioner, with the approval of the mayor, may establish and from time to time alter or amend fees —

(1) For producing for inspection the plans of buildings, as provided in section one hundred and nine.

(2) For issuance of a special foundation permit, as provided in paragraph (d) of section one hundred and eleven.

(3) For written interpretation of this code given for the purpose of an appeal from a disallowance as provided in paragraph (g) of said section one hundred and eleven.

(c) No fee paid in connection with an application for a permit shall be returned, whether or not the permit is granted.

**SECTION 113. *Inspection.*** — (a) The commissioner shall examine each site, application for permit to erect or enlarge a building or structure upon which has been received, and shall examine all buildings, applications for permit to enlarge, alter, repair, move, demolish or change the occupancy of which has been received. He shall inspect all such buildings and structures from time to time during and finally upon the completion of their erection, enlargement, alteration, repair, moving or demolition. He shall make a record of every such examination and inspection and of all violations of this code. The publication of such records shall be privileged.

(b) No building operation requiring a permit shall be commenced until the permit holder or his authorized agent shall have posted a building permit card in a conspicuous place protected from the weather

on the front of the premises and in such a position as to permit the commissioner to make the required entries thereon respecting inspection of the work. Such card shall be preserved and shall remain posted until the completion of the work.

**SECTION 114. *Posting Floor Loads.*** — No existing or new building shall be occupied for any purpose which will cause the floors thereof to be loaded beyond their safe capacity as specified in this code; provided, that the commissioner may permit occupancy of a building for mercantile, commercial or industrial purposes, by a specific business, when he is satisfied that such safe capacity will not thereby be exceeded, even though the class of occupancy of such business, under this code, requires a greater load capacity. In every such case the safe floor loads, as determined by the commissioner, shall be marked on metal plates of approved design which shall be supplied and securely affixed by the owner of the building in a conspicuous place in each story to which they relate. Such plates shall not be removed or defaced, and if lost, removed or defaced shall be replaced by such owner. No such owner shall place or permit to be placed, or to remain on any floor of a building a greater load than the safe load so determined and posted.

**SECTION 115. *Annual Report.*** — The commissioner shall annually, not later than February first, submit a report to the mayor, covering the work of the department during the preceding calendar year, and shall incorporate in said report a summary of the

decisions of the board of appeal, a summary of the proceedings of the board of examiners and of the board of examiners of gasfitters, during said year, and his recommendations as to desirable amendments of this code.

*SECTION 116. Powers and Duties of Building Commissioner.* — (a) The commissioner and the health commissioner shall severally enforce the provisions of this code relative to his powers and duties and they may, themselves or by their respective duly authorized representatives, enter any building or premises in said city to perform any duty imposed upon them, respectively, by this code.

(b) Upon notice from the commissioner that work on any building or structure is being done contrary to the provisions of this code or in a dangerous or unsafe manner, such work shall be immediately stopped. Such notice shall be in writing and given to the owner of the property, or his agent, or the licensed builder or mechanic doing the work, and shall state the conditions under which work may be resumed.

(c) Whoever hinders or prevents, or attempts to hinder or prevent, the commissioner or his authorized representative from entering a building, structure or enclosure, or part thereof, in the performance of his duty in the enforcement of any provision of this code shall be punished by a fine of not less than fifty nor more than one hundred dollars. Each day during any portion of which such hindering continues shall be considered a separate offence.

(d) Every building of which the exits are insufficient shall be provided with exits satisfactory to

the commissioner; and every building which exists, or is being used or occupied, in violation of any provision of this code, which in accordance with section one hundred and seven applies to said building, shall be made to conform to such provision; and every building which is dangerous or unsafe shall be made safe or removed; or every such building shall be vacated forthwith on order of the commissioner, with the approval of the mayor. Such order shall be in writing and shall be addressed and delivered, or mailed, postage prepaid, to the owner or tenant, if he is known and can be found, or otherwise by posting an attested copy of the order in a conspicuous place upon an external wall of the building, and shall state the conditions under which the building may again be used or occupied. An attested copy so posted shall not be defaced or removed without the approval of the commissioner. If in the opinion of the commissioner the public safety so requires the commissioner, with the approval of the mayor, may at once enter the building or other structure which he finds unsafe or dangerous, or land on which it stands, or the abutting land or buildings, with such assistance as he may require, and make safe or remove said unsafe or dangerous building or other structure and may protect the public by a proper fence or otherwise as may be necessary, and for this purpose may close a public or private way.

(e) A claim for the expense incurred by the commissioner under paragraph (d) shall constitute a debt due the city upon completion of the work and rendering to the owner of an account therefor and recoverable from the owner in an action of contract.

Said debt, together with interest thereon at the rate of six per cent per annum from the date upon which said debt became due, shall constitute a lien upon the real estate on which the expense was incurred in the manner hereafter provided. Such lien shall take effect upon the filing, within ninety days after the debt became due, for record in the registry of deeds for Suffolk county, or in the case of registered land with the assistant recorder for the Suffolk district, of a statement of the claim, signed by the commissioner, setting forth the amount claimed without interest. Such lien shall continue for two years from the first day of October next following the date of filing said statement. Such lien may be dissolved by filing for record in such registry of deeds or with said assistant recorder, as the case may be, a certificate from the collector of taxes that the debt for which such lien attached, together with interest and costs thereon, has been paid or legally abated. The collector shall have the same powers and be subject to the same duties with respect to such claim as in the case of the annual taxes upon real estate, and the provisions of law relative to the collection of such annual taxes, the sale of land for the non-payment thereof, and the redemption of land so sold shall apply.

(f) The owner of the real estate to which a lien has attached, as provided in paragraph (e), within ninety days after the statement of said lien was filed in the registry of deeds or with said assistant recorder, as the case may be, may apply in writing to the commissioner for a hearing and such hearing shall be given by the commissioner within a reasonable time thereafter. The commissioner, if he is

satisfied after said hearing that the amount of the claim is more than the amount actually expended to make safe or remove the building or structure, may reduce the amount of the claim to the amount so actually expended. If the owner of said premises is aggrieved by such decision of the commissioner he may, within thirty days after notice of said decision has been mailed to him, appeal to the municipal court of the city of Boston, which shall hear and finally establish the amount of the claim.

(g) Any requirement necessary for the strength or stability of an existing or proposed structure or for the safety of the occupants thereof, not specifically covered by this code, shall be determined by the commissioner subject to appeal to the board of appeal.

(h) The commissioner shall examine every building reported as dangerous or damaged, and shall make a written record of such examination, stating the nature and estimated amount of the damage, and the purpose for which the building was used, and in case of fire the probable origin thereof.

(i) The commissioner and the health commissioner shall from time to time, as either deems proper, inspect the gas fixtures and appliances in any building and shall make such rules, regulations and requirements relating thereto as they deem safety requires, and the owner of such building shall comply therewith. The materials used and work performed in gas fitting shall be subject to such regulations as shall be made by the health commissioner and the building commissioner.

(j) The commissioner shall make and issue rules and regulations governing the tearing down of buildings.

(k) The provisions of this section shall apply to existing as well as new buildings.

(l) Whoever desires to substitute for the materials or methods covered by this code, materials or methods of construction or maintenance not covered thereby, shall present to the commissioner plans, methods of analysis, and tests or other information substantiating the analysis of the system or qualities of the material and shall make such additional tests or present satisfactory evidence of such tests as the commissioner may require. The costs of any tests required to determine acceptability of substitute materials or methods shall be paid by the applicant. When the strength of any construction cannot be satisfactorily determined by the application of accepted engineering principles, its safe strength shall be determined as one sixth of the ultimate strength evidenced by tests of full size units or assemblies thereof of such construction so loaded as to produce critical stresses. Such materials or methods of construction shall not be used until after the commissioner has issued regulations fixing the practices to be followed, but no such regulation shall have the effect of altering the working stresses for any material herein mentioned or of reducing the fire-resistive and fire-protective requirements of this code.

SECTION 117. *Board of Appeal.* (a) There is hereby established in the city of Boston a board, to be called the board of appeal, and to consist of five members appointed by the mayor in the following manner:—One member from two candidates, one to be nominated by the Boston Real Estate Exchange and one by the Massachusetts Real Estate

Exchange; one member from two candidates, one to be nominated by the Boston Society of Architects and one by the Boston Society of Civil Engineers; one member from three candidates, one to be nominated by the Master Builders Association, one by the Building Trades Employers' Association and one by the Building Contractors Association of Massachusetts, Inc.; one member from two candidates to be nominated by the Building Trades Council of Boston and Vicinity; and one member selected by the mayor.

(b) Upon the expiration of the term of office of a member of said board in office on the effective date of this code his successor shall be appointed for the term of five years; and subsequent appointments to said board shall be for terms of five years each. Vacancies shall be filled for an unexpired term in the manner in which original appointments are required to be made. Each member of said board shall be paid ten dollars for every day or part thereof of actual service, but no member shall be so paid more than one thousand dollars in any one year. No member shall act in a case in which he has a personal interest, and when a member is so disqualified, or absent, the remaining members shall designate a substitute.

(c) Members of said board shall be residents of or engaged in business in the city of Boston.

(d) Said board shall cause to be made a detailed record of all its proceedings, which shall set forth the reasons for its decisions, the vote of each member participating therein, the absence of a member, the name of his substitute and any failure of a member to vote.

(e) The board shall establish rules and regulations for its own procedure not inconsistent with this code.

SECTION 118. *Appeals.* — (a) A person whose application for a permit has been refused by the commissioner may appeal to said board of appeal within ninety days thereafter. A person who has been ordered by the commissioner to incur expense may so appeal therefrom within thirty days of the date of such order, except that, in case of a building or structure which, in the opinion of the commissioner, is unsafe or dangerous, the commissioner may in his order limit the time for such appeal to a shorter period. A person aggrieved by an adverse interpretation of this code and a disallowance by the commissioner of proposed construction thereunder, as provided in section one hundred and eleven, may so appeal from such disallowance within thirty days after the date thereof. Appeals hereunder shall be on forms provided by the commissioner and shall be accompanied by such fee as may be established by the commissioner, with the approval of the mayor.

(b) The commissioner may refer without fee to the board of appeal for its decision such cases as, in his opinion, justice requires.

SECTION 119. *Decisions of the Board of Appeal.* — (a) The board of appeal, when so appealed to and after a hearing, may vary the application of any provision of this code to any particular case when in its opinion the enforcement thereof would do manifest injustice, and would be contrary to the spirit and purpose of this code.

(b) Every decision of said board shall be in writing, shall indicate the vote of each member upon the decision, and if it is to vary the application of any provision of this code or modify an order of the commissioner, shall require the assent of at least four members. Every decision shall promptly be filed in the office of the commissioner, and shall be open to public inspection; a certified copy shall be sent by mail or otherwise to the appellant and a copy shall be kept publicly posted in the office of the commissioner for two weeks after filing.

(c) A decision of said board to vary the application of any provision of this code or modify an order of the commissioner shall specify in what manner such variation or modification, respectively, is made, the conditions upon which it is made and the reasons therefor.

(d) Said board shall in every case reach a decision without unreasonable or unnecessary delay.

(e) If the refusal, order or disallowance of the commissioner is reversed or modified, or the application of any provision of this code is varied by a decision of said board, the commissioner shall immediately take action in accordance with such decision; but no decision of said board shall be regarded as establishing a precedent or be held to amend this code or the commissioner's interpretation thereof.

(f) A person aggrieved by a decision of said board, whether previously a party to the proceeding or not, or a municipal officer or board, may, within fifteen days after the filing of such decision in the office of the commissioner, bring a petition in the supreme judicial court for the county of Suffolk for a writ of certiorari to correct errors of law in

such decision, and the provisions of section four of chapter two hundred and forty-nine of the General Laws shall, except as hereinbefore provided, apply to such petition.

**SECTION 120. *Board of Examiners.*** — (a) There is hereby established in the city of Boston a board of examiners to consist of three members appointed by the mayor. Said board shall exercise the powers and perform the duties herein provided. Upon the expiration of the term of office of a member of said board in office on the effective date of this code his successor shall be appointed for the term of three years; and subsequent appointments to said board shall be for terms of three years each. Vacancies shall be filled by appointment by the mayor for the remainder of the unexpired term. Each member shall receive ten dollars for every day or part thereof of actual service, but not more than one thousand dollars in any one year.

(b) Said board shall hold examinations, under rules and regulations adopted by it, of persons desiring to be registered as qualified to have charge or control of the construction, alteration, removal or tearing down of buildings or structures, or the installation or repair of elevators and escalators. Due notice of the time and place for such examinations shall be posted in the office of the building department and published in the City Record.

(c) Said board shall establish various classes of persons to be registered, shall determine the qualifications required for each class, and after examination shall register in each class the persons found to possess the requisite qualifications therefor. The

name and address of each person so found to be qualified, with the designation of the class in which he is registered, shall thereupon be certified by said board to the commissioner, who shall make a record thereof, which shall be open to public inspection.

(d) Except as otherwise provided in section one hundred and eleven, all work of erecting, enlarging, altering, repairing, moving and demolishing of buildings or structures and installing and repairing of elevators and escalators in the city of Boston shall be under the charge, control and personal supervision of a licensed builder or mechanic, qualified by education, training and experience for the performance of that duty in a manner which shall preserve the public safety and conform to this code and all other pertinent laws and ordinances.

(e) Any person who shall by affidavit, together with such other evidence as may be required by said board, show to it that he has had charge or control of such work in the class in which he applies to be registered, and shall satisfy the board that he is qualified by education, training and experience to have charge or control of such work, may, without other examination, be registered in such class and be certified to the commissioner as a person qualified within such class.

(f) Said board, upon payment of the required fee, shall issue a license to each person so certified by it to the commissioner. Each license shall expire one year from the date of its issuance. Said board shall renew a license, upon the expiration thereof and upon payment of the required fee therefor, for the further period of one year from the date of renewal. The fees to be paid to said board for such

licenses and renewals shall be as provided in chapter two hundred and ninety-seven of the acts of nineteen hundred and thirty-one.

(g) Any person who is duly licensed as aforesaid shall be entitled to have charge or control of any work described in this section, in the class in which he is registered, until his license is revoked or suspended by the commissioner, upon the order of said board. No such license shall be revoked or suspended except upon proof, satisfactory to said board, of specific charges, filed with said board by the commissioner or other person, that the licensee has been careless or negligent in the performance of his duty in connection with work under his charge or control, or has caused or permitted a violation of this code in connection therewith, or that this code has been violated in connection with such work and that the licensee, being in charge of such work, knew, or, in the exercise of due diligence, should have known, of such violation. Upon learning of such carelessness, neglect of duty or violation of this code, the commissioner shall file charges with said board and prosecute them. Upon the filing thereof by the commissioner or other person, said board shall give to the licensee notice of a hearing thereon, which hearing shall be held by said board not less than seven days after date of said notice. Such notice shall be served upon the licensee either by service in hand or by registered mail, shall state the time and place of the hearing and shall contain a copy of the charges. At such hearing the licensee may be represented by counsel, and the commissioner may be assisted by a representative of the law department of the city.

(h) If, for any cause, a person licensed as herein provided shall cease to have charge or control of work described in this section before such work is finished, the work shall stop until another person duly licensed for the doing of such work has been placed in charge thereof.

(i) Whoever violates any provision of this section shall be punished by a fine of not more than fifty dollars.

**SECTION 121. *Board of Examiners of Gasfitters.***

— (a) There is hereby established in the city of Boston a board of examiners of gasfitters, to consist of three members, who shall be the building commissioner, the health commissioner and a licensed master gasfitter. The member of said board who is a licensed master gas fitter shall be appointed annually by the mayor for a term ending on the first day of May of the year next ensuing, and he shall receive ten dollars for every day or part thereof of actual service as a member of said board. He shall have been continuously engaged in business as a master gasfitter during the five years next preceding his appointment.

(b) Said board shall hold examinations, under rules and regulations adopted by it, of persons desiring to engage in business as master gasfitters or to work as journeyman gasfitters. Due notice of the time and place for such examinations shall be posted in the office of the department and published in the City Record.

(c) Said board shall determine the qualifications required for registration as master gasfitter and as journeyman gasfitter, and after examination shall

register as such the persons found to possess the requisite qualifications. Said board shall, without re-examination, register as qualified master gasfitters or journeyman gasfitters, as the case may be, persons desiring so to be registered who were so licensed before the effective date of this code. The name and address of each person so found to be qualified and registered, and the place of business of each person qualified as a master gasfitter, shall thereupon be certified by said board to the commissioner who shall, upon payment of the required fee, issue to each person so registered and certified a license to engage in business as a master gasfitter or to work as a journeyman gasfitter, as the case may be.

(d) Each license issued hereunder after the effective date of this code shall expire one year after the date of its issuance. Licenses for gasfitters issued before this code takes effect shall expire on the anniversary of the date of issuance next after this code takes effect. The commissioner shall, upon payment of the required fee, renew for a period of one year from the date of renewal a license about to expire or which has expired, except that, unless by order of said board, he shall not renew the license of any person whose registration has been cancelled, or whose license has been revoked or suspended. The registration of a person whose license has not been renewed within one year after its expiration shall be cancelled.

(e) The fee for issuance or renewal of a master gas fitter's license shall be two dollars and that for issuance or renewal of a journeyman gasfitter's license shall be fifty cents; provided, that such fees may be changed from time to time by the

building commissioner, with the approval of the mayor.

(f) Except as otherwise provided in this section all gas fitting in buildings shall be done by licensed master gasfitters, either themselves or through licensed journeymen gasfitters employed by them. A firm or corporation employing journeymen gasfitters shall be deemed to be licensed for the purpose of this section if a member of the firm or an officer of the corporation is duly licensed as a master gasfitter.

(g) No person shall connect, disconnect or remove a gas meter, except the duly authorized representative of the gas company owning such meter. Nothing in this section shall be construed to affect the operations of a gas company upon its own premises or upon its mains and service pipes.

(h) Whoever violates any provision of this section shall be punished by a fine of not more than one hundred dollars, and, in addition, if the offender is licensed under this section, his license shall be revoked or suspended by the commissioner, when so ordered by said board after a hearing.

SECTION 122. *Penalties.* — (a) A building or structure which is erected or maintained in violation of any provision of this code shall be deemed a common nuisance without other proof thereof than proof of the unlawful construction or maintenance, and the commissioner may abate and remove it in the same manner in which boards of health may remove nuisances under sections one hundred and twenty-three to one hundred and twenty-five, inclusive, of chapter one hundred and eleven of the General Laws.

(b) Except as otherwise provided in this code, whoever violates any provision thereof, or whoever builds, alters, or maintains a structure or a part thereof in violation of any provision thereof, shall be punished by a fine of not exceeding five hundred dollars. Each day during any portion of which such violation is allowed to continue, or is permitted by the owner, shall be considered a separate offence.

SECTION 123. *Enforcement Jurisdiction.* — (a) Any court having jurisdiction in equity, or any justice thereof, may, upon the application of the city by its attorney —

(1) Restrain the construction, alteration, repair, maintenance, use or occupation of any building or structure constructed, maintained, used or occupied in violation of any provision of this code, and order its removal or abatement as a nuisance;

(2) Restrain the further construction, alteration, repair, maintenance, use or occupation of any building or structure which is unsafe or dangerous;

(3) Restrain the unlawful construction, alteration, repair, maintenance, use or occupation of any building or structure;

(4) Compel compliance with the provisions of this code;

(5) Order the removal by the owner of a building or structure unlawfully existing and authorize the commissioner, with the written approval of the mayor, in default of such removal by the owner, to remove it at the owner's expense.

(b) The municipal court of the city of Boston, concurrently with the superior court, shall have jurisdiction throughout the city of prosecutions

and proceedings at law under the provisions of this code, and all other pertinent laws and ordinances.

(c) Upon the entry of any case brought under any provision of this code the court shall, at the request of either party, advance the case, so that it may be heard and determined with as little delay as possible.

*SECTION 124. Classification of Buildings by Types of Construction.* — (a) Buildings shall be classified by types of construction representing varying degrees of resistance to fire. All buildings required to be of a given type of construction shall conform to the minimum requirements of this code for that type, but materials and combinations of materials which offer greater resistance to fire than those specified for minimum requirements may be used. Every building shall be classified as of the most fire-resistive type all of the minimum requirements of which it fully meets. No building or portion thereof shall be required to conform to a type of construction more fire-resistive than that specified for its occupancy and size, or for its location in the fire zones, in this code.

(b) When two or more types of construction occur in the same building and are separated as provided in this code, each portion so separated may be classified as of the type of construction to which it conforms; otherwise the entire building shall be classified as of the least fire-resistive type of construction used, and shall be subject to the restrictions of this code imposed upon that type.

(c) An existing building which cannot be definitely classified as one of the types defined in sections

one hundred and twenty-five to one hundred and thirty-one, inclusive, shall be deemed for the purpose of this code to belong to the less fire-resistive of the two types to which it most nearly conforms.

**SECTION 125. *Types of Construction.*** — All buildings shall be classified for the purpose of this code in the following types of construction: —

Type I. Fireproof.

Type II. Semi-Fireproof.

Type III. Heavy Timber and Masonry.

Type IV. Light Wood and Masonry.

Type V. Metal Frame.

Type VI. Wooden Frame.

**SECTION 126. *Type I, Fireproof Construction.*** — Buildings of Type I construction shall be of incombustible materials in all structural parts; their exterior bearing walls and frames shall be of four-hour fire-resistive construction and their floors and roofs shall be of three-hour fire-resistive construction and shall furnish protection of three-hour fire-resistive rating against the spread of fire.

**SECTION 127. *Type II, Semi-Fireproof Construction.*** — Buildings of Type II construction shall be of incombustible materials in all structural parts; their exterior bearing walls shall be of four-hour fire-resistive construction, their columns and frames shall be of two-hour fire-resistive construction and their floors and roofs shall be of one-hour fire-resistive construction and shall furnish protection of one-hour fire-resistive rating against the spread of fire.

**SECTION 128. *Type III, Heavy Timber and Masonry Construction.*** — Buildings of Type III shall have exterior bearing walls of masonry or other construction of incombustible materials of four-hour fire-resistive construction, and their frames, floors and roofs shall be of heavy timber construction without concealed air spaces.

**SECTION 129. *Type IV, Light Wood and Masonry Construction.*** — Buildings of Type IV shall have exterior bearing walls of masonry or other construction of incombustible materials of four-hour fire-resistive construction and their frames, floors and roofs may be of wood.

**SECTION 130. *Type V, Metal Frame Construction.*** — Buildings of Type V shall have walls, frames, floors and roofs of metal or other incombustible materials which may be without protection against fire.

**SECTION 131. *Type VI, Wooden Frame Construction.*** — Buildings of Type VI may have walls, frames, floors and roofs of wood.

**SECTION 132. *Occupancies classified.*** — (a) Every building, whether existing or new, shall, for the purpose of this code, be classified according to its principal occupancy, as follows:—

- Group A. Theatres.
- Group B. Halls.
- Group C. Schools.
- Group D. Hospitals and detention buildings.
- Group E. Commercial buildings of hazardous occupancy.

Group F. Offices and commercial buildings.

Group G. Commercial buildings of non-hazardous occupancy.

Group H. Dwellings, large.

Group I. Dwellings, small.

Group J. Miscellaneous structures.

(b) An occupancy not mentioned specifically in this section or in the definitions of groups and subdivisions of groups contained in Parts 3 to 12, inclusive, of this code, or about which there is any question, shall be classified by the commissioner and included in the group which it most nearly resembles, as regards fire hazard and danger to the lives of persons.

**SECTION 133. *Change of Occupancy.*** — The occupancy of a building shall not be changed unless such building conforms or is made to conform with the requirements of this code for the group in which it is to be classified, except that the occupancy of an existing building may be changed as provided in section one hundred and seven.

**SECTION 134. *Multiple Occupancies.*** — When a building contains two or more units of occupancy, whether of the same or of different occupancy classifications, the separations between such units and the aggregate area of such units within the building shall be as provided in this code.

**SECTION 135. *Elevators and Escalators.*** — No elevator or escalator shall be installed in a building or structure except under the provisions of sections sixty-two to seventy-one, inclusive, of chapter one

hundred and forty-three of the General Laws and the regulations issued thereunder, and in conformity with section one hundred and twenty of this code.

**SECTION 136. *Building Height.*** — (a) No building or structure shall be so erected or altered that any part thereof shall be higher above the ground than two and one half times the shortest horizontal distance of that part from the further side of the street upon which it fronts; provided, that, in case of a building at the intersection of two streets, within one hundred and fifty feet measured along the streets from the intersection of the nearer side lines thereof, the width of each street shall for the purpose of this section be taken as the width of the wider street.

(b) No building or structure shall be erected or altered to a greater height measured to the highest point of the roof thereof than one hundred and fifty-five feet except as provided in this paragraph. If a building or structure shall be erected or altered to a greater height than one hundred and fifty-five feet every part of such building shall not be higher above the ground than one hundred and twenty-five feet plus two and one half times the shortest horizontal distance of that part from the nearest lot or street line. No building shall be erected or enlarged to contain a volume above the grade of the ground greater than the buildable area of the lot multiplied by one hundred and fifty-five feet.

(c) In determining the height of any part of a building for the purposes of this section, the grade of the ground from which measurement shall be made shall be that from which the height of the building is measured as defined in section one hundred and

six. Flag poles and weather vanes shall not be considered a part of a building for the purposes of this section.

## PART 2.

### FIRE LIMITS.

#### SECTION

- 201 — Fire Limits.
- 202 — Boundaries.
- 203 — Construction within the Fire Zones.

SECTION 201. *Fire Limits.* — For the purposes of this code there shall be established in the city of Boston two fire districts or zones within which building construction shall be limited as provided in this part of the code. Outside of the boundaries of the zones no limitation is placed by this part of the code upon the construction of buildings.

SECTION 202. *Boundaries.* — (a) The boundaries of the first fire zone shall be the boundaries of the building limits as they existed prior to the twenty-second day of September in the year nineteen hundred and thirteen.

(b) The boundaries of the second fire zone shall be the boundaries of the building limits as they were established on and after the twenty-second day of September in the year nineteen hundred and thirteen.

(c) The city council of the city of Boston may by ordinance from time to time extend either fire zone and re-establish its boundaries.

#### SECTION 203. *Construction within the Fire Zones.*

— (a) Buildings hereafter erected in the first or

second fire zone shall be of Type I, Type II, Type III or Type IV construction except as hereinafter provided.

(b) The limitations of this section shall not apply to buildings not over twenty-seven feet high on wharves and buildings for the storage and handling of coal or grain in bulk, of Type V or Type VI construction, in either fire zone, if the exterior thereof is covered with slate, tin, sheet metal or other equally fire-resistive construction, erected with the approval of the commissioner and subject to such conditions as he may in each case specify.

(c) Temporary structures to be used in connection with construction work and temporary reviewing stands may be erected in either fire zone and of any type of construction subject to the approval of the commissioner and to such conditions and for such time as he may in each case specify.

(d) Buildings of Type VI construction for dwellings for one or two families may be erected or enlarged in the second fire zone where the area of each does not exceed sixty per cent of the area of the lot on which it is located and the roof is pitched at not less than thirty degrees with the horizontal.

(e) Buildings of Type V construction may be erected or enlarged for use as garages in the second fire zone providing they are equipped with fire windows and are not within two feet of a lot line or within five feet of a building of Type VI construction and the height does not exceed one story and the area six hundred square feet and the capacity two cars.

(f) Buildings of Type V construction for other occupancies may be erected in the second fire zone

providing the location and the occupancy are approved by the building commissioner.

(g) Buildings in the first or second fire zone erected, enlarged or converted to use as a garage for more than four cars shall be of Type I or Type II construction and if such garage be more than one story in height it shall be of Type I construction.

(h) Every building in Group C in the first or second fire zone shall be of Type I or Type II construction.

### PART 3.

#### SPECIAL REQUIREMENTS FOR GROUP A OCCUPANCY: THEATRES.

##### SECTION

- 301 — Group A Occupancy: Type, Height, Area.
- 302 — Separation of Occupancies.
- 303 — Exterior Walls.
- 304 — Enclosure of Vertical Openings.
- 305 — Exits and Entrances.
- 306 — Aisles and Seating.
- 307 — Exit Lights.
- 308 — Light and Ventilation.
- 309 — Stage Ventilators, Group A Occupancy.
- 310 — Proscenium.
- 311 — Stage Construction.
- 312 — Dressing Rooms and Workshops.
- 313 — Fire-Extinguishing Apparatus.
- 314 — Projection Room.

SECTION 301. *Group A Occupancy: Type, Height, Area.* — (a) Group A shall include every building containing an auditorium and a permanent stage equipped with a gridiron or other means of hanging scenery, and primarily adapted for the giving of plays, operas or similar forms of entertainment.

(b) Buildings or parts of buildings, classified for occupancy in Group A, shall be of Type I construc-

tion, except that portion of the stage which, under the provisions of section three hundred and eleven, may be of wood or unprotected metal, and they shall not hereby be limited as to seating capacity, area or height.

SECTION 302. *Separation of Occupancies.* — Portions of a building of Group A occupancy may be used for purposes other than the giving of plays, operas and the like, but the parts given to such other occupancies shall be separated from that devoted to Group A occupancy by separations specified in Part 13.

SECTION 303. *Exterior Walls.* — (a) Exterior walls or parts of walls, except where fronting on a street, which are less than five feet from a property line, shall be without openings, except that openings in such walls at the ends of courts shall be allowed when protected by Class B fire doors or fire windows. Openings in such walls or parts of walls which are five feet or more but less than ten feet from a property line shall be protected by Class B fire doors or fire windows.

(b) In an exterior wall, every opening which faces, at a distance of less than twenty feet, the further side of a street or a combustible wall or roof or an unprotected opening in a wall or roof of another building on the same lot, shall be protected by Class B fire doors or fire windows.

(c) The commissioner may waive the requirements of this section, for protection or prohibition of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the

owner agrees in a writing recorded in the registry of deeds for Suffolk county to comply with the said requirements on demand of the commissioner.

**SECTION 304. *Enclosure of Vertical Openings.*** —

(a) Stair or ramp exits from only the first or lower balcony need not be enclosed. Stair or ramp exits from smoking rooms, lounges or other public rooms in the basement shall be enclosed in the basement or first story, and the doors shall be self-closing but need not be fire doors. Other stairways and ramps which pierce only one floor shall be enclosed in the story above or below but such stairways or ramps which serve as required exits from one story shall be enclosed in the other story. Stairways or ramps serving dressing rooms need not be enclosed above the stage or first floor if separated from the stage by a two-hour separation. Other stairways and ramps shall be enclosed in all stories in which they occur. There shall be no openings in stair or ramp enclosures except entrance and exit doorways and the openings required for ventilation.

(b) Vertical openings for elevators serving dressing rooms need not be enclosed above the stage or first floor if they are separated from the stage by a two-hour separation. Vertical openings for elevators serving the gridiron and fly galleries need not be enclosed above the stage level. All other vertical openings for elevators and vertical openings for ventilation or other purposes, except as otherwise specified in this section, shall be enclosed.

**SECTION 305. *Exits and Entrances.*** — (a) Group A buildings shall be so located that the main entrances

shall open directly from a public street or streets not less than thirty feet wide. The main entrance or entrances, which may also serve as exits, shall have in the aggregate twenty inches of unobstructed width for each one hundred persons to and including one thousand persons, with an additional ten inches for each additional one hundred persons to and including one thousand additional persons, and an additional five inches for each additional one hundred persons over two thousand, all based on the total seating capacity of the building served by said entrances. No main entrance shall be less than fifteen feet in clear width between walls or in aggregate width of doorways and of passageways but such width shall not be required to exceed forty feet in width. Doorways and passageways in such entrances shall be not less than five feet in clear width.

(b) Adjacent to the main floor and each balcony of the auditorium and between the auditorium and the main entrance, in the path of normal entrance and egress, there shall be a foyer consisting of a lobby, corridor or passageway, one or more, the aggregate floor area of which shall be at least equal to one square foot for each seat in such division of the auditorium.

(c) There shall be at least two remote exits from the main floor and from each balcony of the auditorium. One of these exits from the main floor and one from each balcony shall open into the foyer required therefor in this section. Both such exits may open into the required foyer if it has two remote exits.

(d) From the main floor and each balcony of the auditorium there shall be at least two paths of exit

independent of one another. Stairways or ramps serving balconies above the first or lowest balcony shall be enclosed and shall discharge directly into a street or open court independently of the other required exit serving the same balcony or balconies and independently of the paths of exit from the main floor. Such stairways or ramps may serve also as exits from the first or lowest balcony. A stairway or ramp serving as an exit only from the first or lowest balcony need not be enclosed and the path therefrom may join a path of exit from the main floor. Where a path of exit joins another at an angle, the common path of exit shall be at least as wide as the sum of the widths of the paths so joined, and the partition or railing which bounds a path so joining another shall either be stopped back from the nearer side of the common path a distance equal to the width of the joining path or shall extend such distance beyond the side of the common path, thus enabling persons either to join the common path before turning or to enter and turn before joining the common path.

(e) Exit stairways or ramps from balconies shall not extend below the level at which they discharge from the building.

(f) Exits and paths of exit, except from boxes seating less than twenty-five persons, shall be not less than five feet wide at any point. The aggregate width of the paths of exit specified heretofore in this section which serve one or more divisions of the auditorium shall be at least twenty inches for every one hundred persons for whom seats are provided in the division or divisions so served. In calculating the required width of each path of exit, persons

seated in the auditorium shall be allotted to those exits therefrom which they can most quickly reach in an emergency, assuming that the emergency exits hereinafter specified are not used, and upon any other reasonable assumption.

(g) In addition to the exits specified in paragraphs (c), (d), (e) and (f) of this section, hereinafter called normal exits, there shall be provided a system of emergency exits as specified in this paragraph and in paragraphs (h) and (i). Emergency exits from the auditorium shall be at least five feet wide and there shall be at least one such exit from each side of the main floor and of each balcony, as remote as practicable from the normal exits. Emergency exits from the main floor shall be exits from the building or shall be connected by passageways with exits from the building independent of the normal exits. The paths of emergency exit from the main floor shall be not less than five feet wide, nor shall the aggregate width be less than five inches for every one hundred persons served. The paths of exit from the emergency exits from balconies shall be either of inside type as specified in paragraph (h) or of outside type as specified in paragraph (i) of this section, or a combination of the two types; provided, that the aggregate width of the paths of emergency exit shall have five inches in width of inside path or ten inches in width of outside path for every one hundred seats in the balcony or balconies served.

(h) An inside path of emergency exit, referred to in the preceding paragraph, shall consist of a foyer with at least fifty square feet of floor for each emergency exit served, and an enclosed stairway or ramp with outside ventilation, with a direct exit from the

building, or an enclosed passageway leading to such an exit, independent of normal exits, or an exit to another building or fire division of Type I or Type II construction. An exit to another building or fire division shall be through a lobby or vestibule of at least one hundred square feet in floor area with outside ventilation and with self-closing Class A fire doors at entrance and exit and shall lead, through adequate corridors, stairways and passageways, to the street. No such exit shall be made through a building or fire division of Group E occupancy. Inside emergency exits shall be not less than three feet wide.

(i) An outside path of emergency exit, referred to in paragraph (g) of this section, shall consist of an exterior fire escape balcony not less than four feet wide at each emergency exit from a balcony and not more than six inches below the sill thereof. Such balconies at the highest level shall be at least eight feet long and at lower levels at least twelve feet long. Fire escape stairs of rise not exceeding eight and one half inches and tread not less than nine and one half inches and not less than thirty inches wide shall lead from all such balconies to the ground. The lowest runs may be hinged and counterweighted. Exterior fire escapes shall be located either in a street or in an open court. Such courts shall be at least six feet wide and open to the sky for the full depth of the auditorium and shall be connected with a street by an open court or an enclosed passageway ten feet high, either of which shall be at least six feet wide. Every such court or passageway shall have such additional width as may be necessary, if any, to provide, when the fire

escape stairs are in position for use, the clear width required for it as a path of emergency exit and as a path of normal exit if so used.

(j) At least one exit, three feet wide, shall be provided on each side of the stage. These exits shall open directly upon a street, or on a passageway or court not less than three feet wide, leading to a street. Ladders may be provided as exits from fly gallery and gridiron. Each tier of dressing rooms shall be provided with at least two remote exits not less than thirty inches wide.

(k) All exit and entrance doors or gates shall swing in the direction of egress and if provided with latches, such latches shall be of self-releasing type such as panic bolts or similar devices, of non-corrodible metal, which will permit the door to open when pressed against. All doors shall be so installed as not in any position to decrease the width of any doorway (except that in which it is installed), stairs, landing, passageway or corridor below the width required.

(l) No mirrors shall be so placed as to give the appearance of a doorway or exit, hallway or corridor, nor shall there be any false doors or windows.

(m) In buildings of Group A the rise of stairs shall not exceed seven and one half inches nor shall the tread be less than ten and one half inches. There shall be no flights of stairs of more than fifteen or less than three risers between landings.

(n) A landing between two flights of stairs in the same direction shall be at least as wide as the stairway and at least four feet long in the direction of travel. Stairs turning at a right angle shall have a square or rectangular landing the full width of the

respective stairways, except that the outer line of the landing shall be curved to a radius not less than two feet, or bevelled two feet, to avoid a deep corner. Where stairs return directly on themselves, a landing without steps shall be provided at least as wide as the stairs, and the outer corners shall be curved or bevelled. Winders may be provided only in stairs from boxes seating less than twenty-five persons. Where two side flights of stairs join and continue in a common flight, a landing without winders shall be provided and the width of the common flight shall be equal to the sum of the widths of the side flights. A door opening into a stairway shall not open immediately upon a flight of stairs, but a landing at least three feet long in the direction of travel shall intervene.

(o) All stairways shall have, on both sides, strong hand rails of metal or hard wood firmly secured about three feet high above the upper tread at each riser, except that stairs less than three feet wide need have a rail only on one side.

(p) Stairways over eight feet wide shall be provided with a central rail of metal or hard wood, not less than two inches in diameter, placed at a height of about three feet above the upper tread at each riser, firmly supported on metal standards. Stairways over twelve feet wide shall have such intermediate rails dividing the stairs into equal runs not over six feet wide. Where hand rails are fastened to walls there shall be a minimum clearance of two inches between the rail and the wall. At the head of each flight of stairs on both sides thereof and at each intermediate rail, if any, there shall be a post or standard at least six feet high to which the rail

or rails shall be secured. The upper ends of hand-rails shall be returned to wall or posts.

(q) Except as otherwise specified in this section, the provisions of Part 18 shall apply to exits from Group A buildings.

**SECTION 306. *Aisles and Seating.*** — (a) In auditoriums, aisles having seats on both sides shall be not less than thirty inches in width at the end remote from an exit and shall be widened by two inches for each ten feet in length measured toward the exit. Aisles having seats on one side only shall be not less than twenty-four inches wide at the end remote from an exit, and shall be widened toward the exit by two inches for each ten feet in length. Side aisles serving more than one exit shall be of uniform width between exits and such width shall be not less than that required by this paragraph at a point midway between the extreme exit.

(b) Aisles shall be so arranged that not more than six seats shall intervene between any seat and the nearest aisle.

(c) There shall be no obstructions of any kind in an aisle. Aisles on the main floor and in balconies may be sloped or stepped. When sloped, the slope shall not exceed two inches vertical in ten inches horizontal. Where stepped the rise shall not exceed twenty-one inches in a horizontal distance of thirty-two inches. Stepped aisles shall not be construed to be stairways.

(d) Auditorium main floors having more than thirty-five rows of seats shall have a cross aisle leading from the center aisle or aisles to the side aisles. Balconies shall have a cross aisle for every twenty

rows of seats and fraction of twenty, such cross aisles to run from side to side of the auditorium. Cross aisles shall be not less than three feet wide in the clear and shall lead to exits that are easily accessible. Vomitories shall be considered entrances and exits.

(e) Seats shall be spaced not less than thirty-two inches except that seats with backs less than one inch thick may be spaced not less than thirty inches back to back. Seats in stepped balconies shall be spaced not less than thirty-two inches back to back. No seats shall be less than eighteen inches in width center to center. All seats shall be securely fastened to the floor, except as otherwise provided in this section.

(f) Seats in boxes accommodating less than twenty-five persons need not be fastened to the floor. Boxes accommodating twenty-five persons or more shall be considered balconies.

SECTION 307. *Exit Lights.* — Over every exit doorway, on the inside, and over every opening to a fire escape, on the inside, there shall be an illuminated sign bearing the word "EXIT" or "FIRE ESCAPE", respectively, in letters not less than four inches high. Each sign shall be provided with two electric lamps.

SECTION 308. *Light and Ventilation.* — (a) Dressing rooms, work shops, toilet rooms, auditoriums, foyers, and other public rooms shall be provided with light and ventilation by means of windows and skylights with an area not less than one eighth the floor area in each room, or they shall be provided with

artificial light and a mechanically operated ventilating system. The mechanically operated ventilating system shall provide for four complete air changes per hour in rooms where required and in the auditorium shall supply at least fifteen cubic feet of fresh air per minute for each occupant thereof. If the velocity of the air entering the room exceeds five feet per second, the opening must be placed more than eight feet above the floor directly beneath. Adequate means shall be provided for the removal of foul air.

(b) Light shall be electric. Auditorium lights shall be on circuits separate from those of the stage and the remainder of the building, and shall be so arranged that they can be turned on from the stage and from at least one other convenient point in the front of the house, with approved indicators to show when the lights are on.

(c) Lights in foyers, stairways, corridors and other paths of exit shall be on circuits separate from those of the stage, auditorium and the remainder of the building and shall be so arranged that they can be turned on from the stage and from at least one other convenient point in the front of the house, with approved indicators to show when the lights are on.

(d) Exit sign lights and selected lamps in foyers, auditoriums, stairways, corridors and other paths of exit sufficient to provide illumination for egress of the audience in case of emergency shall be wired on separate circuits, and these lights, hereinafter referred to as emergency lights, shall be kept lighted when the building is occupied, except that outside balconies and fire escapes need not be lighted before sunset nor auditorium lights during a performance.

The emergency lights may also include lights on switchboards, in projection rooms, in boiler rooms and at other critical points. Emergency lights shall be protected from possible physical damage.

(e) The emergency lights shall be provided with a second or emergency source of current and a transfer switch which will automatically disconnect the normal service and instantly connect the emergency service when the voltage of the normal service falls below fifty per cent of the nominal lamp voltage and which will also automatically disconnect the emergency service and instantly connect the normal service when the voltage of the latter is restored to eighty per cent of the nominal lamp voltage. The emergency source of current shall be either:—

(1) A separate feeder from a substation of the service company other than that from which the normal service is taken, or

(2) A separate feeder from a reliable generating plant independent of that from which the normal service is taken, or

(3) An approved storage battery.

(f) Glass in lighting fixtures hung in auditoriums, lobbies or other public places shall be secured from falling by an approved method.

SECTION 309. *Stage Ventilators, Group A Occupancy.*—(a) There shall be one or more ventilators, constructed of metal or other non-combustible material, near the center and above the highest part of the stage. Such ventilator or ventilators shall be raised above the stage roof and shall have a total ventilating area at least equal to ten per cent of the floor space behind the proscenium wall, at the stage

floor level, not separated from the stage by a two-hour separation.

(b) Doors or covers for ventilators shall open by gravity. Doors or covers shall be held closed and manually operated by means of cords extending to each side of the stage. These cords shall each be equipped with three fusible links one of which shall be placed in the ventilator above the main roof level and the other two at approved points not affected by sprinkler heads. Fusible links shall be of an approved type which will release at a temperature of one hundred and sixty degrees Fahrenheit. Each ventilator shall be opened and closed at least once before each performance.

(c) Glass, if used in ventilators, may be either plain or wired. If plain glass is used, a suitable wire netting shall be placed both above and below the glass.

**SECTION 310. *Proscenium.*** — (a) The stage portion shall be separated from the auditorium by not less than four-hour fire-resistive construction, as specified in Part 22. Such separation shall be known as the proscenium wall. This wall may be offset as desired, but such offsets shall also be of not less than four-hour fire-resistive construction. The proscenium wall shall not be finished or covered with combustible materials.

(b) The proscenium opening, the main opening for the viewing of performances, shall be provided with a proscenium curtain as follows:—

(1) The proscenium curtain shall be of incombustible and fire-resistive material. If of fabric, it shall be of asbestos cloth containing not over ten

per cent by weight of cotton or other combustible fibre, shall be reinforced by wire and shall weigh not less than three pounds per square yard.

(2) Proscenium curtains of other materials than fabric, which are able to withstand a standard fire test, as specified in Part 22, for thirty minutes, may be used with the approval of the commissioner.

(3) If the proscenium opening is not more than thirty-five feet wide the curtain shall have a rigid metal member at the top and at the bottom edge protected by the fabric on both stage and auditorium sides. If the proscenium opening is more than thirty-five feet wide the curtain shall have a rigid steel frame on all sides braced and constructed to the satisfaction of the commissioner and protected from fire on both stage and auditorium sides.

(4) The proscenium curtain shall extend into non-combustible grooves at the side a distance of at least twelve inches and the edges of the curtain shall be retained in the groove by means of a taut steel cable or by other approved means. The curtain shall overlap the top of the proscenium opening not less than eighteen inches. At the bottom edge the curtain shall be padded for a depth of at least four inches with flexible incombustible material.

(5) The proscenium curtain shall be so rigged, counter balanced, and operated that it can be quickly released to descend by gravity, and completely close the opening in case of fire. The releasing device and its location shall be approved by the commissioner.

(6) The proscenium curtain shall be raised and lowered at least once before every performance and shall be lowered at the close of every performance.

The operation of the curtain by means of the releasing device shall be tested at intervals as required by the commissioner.

(c) The proscenium wall may have, in addition to the proscenium opening not more than two openings at the orchestra pit level and two openings at about the auditorium floor or stage level, none of which shall be more than twenty-five square feet in area. Each such opening shall be protected on each side of the wall by a Class A fire door as specified in Part 22. Ventilating ducts may pass through the proscenium wall, provided they are equipped with automatic-closing shutters of approved fire-resistive construction with fusible links.

SECTION 311. *Stage Construction.* — (a) The portion of the stage floor used in the working of scenery, traps or other mechanical apparatus, may be of Type III floor construction, and steel beams need not be protected against fire. This construction shall not extend beyond the proscenium wall or the proscenium curtain, and shall not exceed the width of the proscenium opening by more than three feet on each side. All other portions of the stage shall be of Type I construction as specified in Part 16. The room or rooms under a stage of other than Type I construction shall not be used for storage or for any purpose other than the working of traps and mechanical apparatus necessary for a performance on the stage.

(b) Gridirons, fly galleries, and pin rails shall be constructed of incombustible materials, but fire-proofing of metal shall not be required.

(c) A protecting hood of incombustible material shall be provided over and the full length of the stage

switchboard. The switchboard shall be protected on the sides and back by a grille of three-sixteenths inch wire with not more than two-inch mesh, or by partitions of incombustible materials having a one-hour fire-resistive rating, and on the front by a railing not less than three feet high.

**SECTION 312. *Dressing Rooms and Workshops.*** — The dressing rooms, workshops and storerooms shall be separated from the stage by a two-hour separation as specified in Part 13.

**SECTION 313. *Fire-Extinguishing Apparatus.*** —

(a) Automatic sprinklers shall be provided throughout, except in auditoriums, foyers, lounges, entrances, exits and projection rooms.

(b) The proscenium opening shall be equipped with an effective water curtain by means either of automatic sprinkler heads of suitable design, or open heads controlled by either of two valves on the stage, one on each side of the proscenium opening.

(c) A portable fire extinguisher or extinguishers of approved type shall be provided on the outside of each projection room near the door or doors.

(d) Portable extinguishers, not less than one for every two thousand square feet of floor area, shall be provided throughout except in entrances and exits.

(e) First aid hose stations shall be provided throughout, except in projection rooms, auditoriums, foyers, lounges, entrances, exits and other rooms used by the public. There shall be one station each side of the stage.

(f) Fire department standpipes shall be provided in buildings more than seventy feet high.

SECTION 314. *Projection Room.* — The size, construction, arrangement and equipment of a projection room shall conform to the requirements of sections seventy-two to eighty-eight, inclusive, of chapter one hundred and forty-three of the General Laws, and to the regulations established thereunder by the commissioner of public safety of the commonwealth of Massachusetts.

## PART 4

### SPECIAL REQUIREMENTS FOR GROUP B OCCUPANCY: HALLS.

#### SECTION

- 401 — Group B Occupancies: Type, Height, Area.
- 402 — Separation of Occupancies.
- 403 — Exterior Walls.
- 404 — Enclosure of Vertical Openings.
- 405 — Exits and Entrances.
- 406 — Aisles and Seating.
- 407 — Exit Lights.
- 408 — Light and Ventilation.
- 409 — Stage and Proscenium.
- 410 — Dressing Rooms, Workshops and Boiler Rooms.
- 411 — Fire-Extinguishing Apparatus.
- 412 — Projection Room.

SECTION 401. *Group B Occupancies: Type, Height, Area.* — (a) Group B shall include places of assembly, not included in Group A, such as churches, gymnasiums, dance halls, and other assembly halls the main floor of which exceeds nine hundred square feet in area, or the total floor area of which, including a balcony, exceeds one thousand square feet.

(b) Buildings or parts of buildings classified for occupancy in Group B, and of the several types of construction, shall not exceed in height and area of units of occupancy the following limits: —

TYPE OF CONSTRUCTION.	HEIGHT.		Maximum Area of Unit (Square Feet).
	Feet.	Stories.	
I . . . . . . . .	Not hereby limited		Not hereby limited
II . . . . . . . .	55	4	18,000
	55	1	24,000
III . . . . . . . .	55	4	17,000
	55	1	20,000
IV . . . . . . . .	45	3	12,000
	45	1	18,000
V . . . . . . . .	45	1	12,000
VI . . . . . . . .	35	1	5,000

The maximum area may be increased proportionately within the limits given as the number of stories is decreased from the maximum.

(c) The first floor of all buildings more than two stories in height shall be of Type I construction. No assembly hall of floor area exceeding thirty-six hundred square feet and no group of assembly halls of aggregate floor area exceeding forty-eight hundred square feet shall be above the first story unless the building is of Type I or Type II construction.

(d) The maximum area provided in this section may be increased fifty per cent if the entire floor area is protected by automatic sprinklers.

**SECTION 402. *Separation of Occupancies.***—Group B occupancies shall be separated from other occupancies, and fire divisions of Group B occupancy shall be separated from adjoining fire divisions as specified in Part 13.

**SECTION 403. *Exterior Walls.***—(a) Exterior walls or parts of walls, except where fronting on a

street, which are less than five feet from a property line, shall be of four-hour fire-resistive construction without openings, except that openings in such walls at the ends of courts shall be allowed when protected by Class B fire doors or fire windows. Such walls or parts of walls which are five feet or more, but less than ten feet from a property line shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows.

(b) Every portion of an exterior wall which faces, at a distance of less than twenty feet, the further side of a street, or a combustible wall or roof or an unprotected opening in a wall or roof of another building on the same lot, shall be of at least two-hour fire-resistive construction, and all openings in such portions shall be protected by Class B fire doors or fire windows.

(c) The commissioner may waive the requirements of this section, for the protection or prohibition of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds to comply with the said requirements on demand of the commissioner.

(d) In buildings of Type V construction, exterior walls of unprotected metal shall be accepted as meeting the requirements of this section for two-hour walls.

**SECTION 404. *Enclosure of Vertical Openings.*—**

(a) Main stair or ramp exits from only the second story need not be enclosed. Stairways or ramps which extend only from a balcony in a hall to the main floor

level need not be enclosed. Other stairways and ramps which pierce only one floor shall be enclosed in the story above or below but such stairways which serve as required exits from one story shall be enclosed in the other. Other stairways and ramps shall be enclosed in all stories in which they occur.

(b) Elevator shafts, ventilation shafts and other vertical openings except stairways and ramps, shall be enclosed.

SECTION 405. *Exits and Entrances.*—(a) Group B buildings shall front upon a public street not less than twenty feet wide or upon an open area not less than twenty feet wide leading to a public street. In this front shall be located the main entrance of the building. The main entrance or entrances, which may also serve as exits, shall have in the aggregate twenty inches of clear width for each one hundred persons to and including one thousand persons, with an additional ten inches for each additional one hundred persons to and including one thousand additional persons, and an additional five inches for each additional one hundred persons over two thousand persons. In a one story or two story building the width of entrance shall be based upon the total seating capacity of the halls served by it. In a building of three or more stories the width of entrance shall be based upon the maximum total seating capacity of the halls served by it which are contained in any two stories. (See definition of "seating capacity.")

(b) Adjacent to the main floor and to each balcony, if any, of an assembly hall and between the hall and its main entrance in the path of normal

entrance and egress, except in the first story, there shall be a foyer, consisting of a lobby, corridor or passageway, one or more, the aggregate floor area of which shall be at least equal to one square foot for each seat in the seating capacity of the hall or balcony so served; provided, that one such area may serve two or more halls or balconies on the same floor level if large enough for the largest two halls so served. A hall, with a balcony seating not more than one hundred and fifty persons, may have a common foyer. A foyer shall have a width of at least ten inches for each one hundred seats in the seating capacity of the largest two halls served by it.

(c) Assembly halls having a seating capacity of fifteen hundred or less shall have exits with an aggregate width of at least twenty-four inches for each one hundred seats thereof and no exit shall be less than three feet wide. Halls having a seating capacity of five hundred or less shall have at least two remote exits. Halls having a seating capacity of more than five hundred, but not more than eight hundred, shall have at least three remote exits. Halls having a seating capacity of more than eight hundred, but not more than one thousand, shall have at least four remote exits of which two shall be at least five feet wide. Halls having a seating capacity exceeding one thousand shall have at least four remote exits five feet wide. Every assembly hall shall have at least two remote and independent paths of exit. Halls having a seating capacity of more than fifteen hundred shall have exits meeting the requirements for normal and emergency exits from the auditoriums of Group A buildings. Every balcony seating more than twenty-five persons shall have two remote exits.

(d) At least one exit from every hall or balcony shall lead into the foyer thereof and all such exits may lead into the foyer if it has two remote exits. Exterior stairways and ramps shall not serve as required exits of Group B buildings except the emergency exits required for halls seating more than fifteen hundred. Exits from foyers and all paths of exit from doorways from assembly halls shall be at least forty-four inches wide and shall have an aggregate width at least equal to twenty inches for each one hundred seats in the seating capacity of the halls of any one story served by them. No point on the main or balcony floor of an assembly hall shall be further from the nearest exit from the story than one hundred and fifty feet along a path of exit.

(e) Enclosed stairways or ramp exits shall discharge directly through an exit from the building or through an enclosed corridor leading to an exit from the building

(f) Doorways from a room leading into a stair enclosure shall have one-way swinging self-closing doors opening in the direction of egress. If doors in exit doorways more than four feet wide have latches, such latches shall be panic bolts or similar approved devices, of non-corrodible metal.

(g) Stairs shall have a handrail on each side. The upper ends of handrails shall return to the wall or to a post.

(h) Except as otherwise specified in this section the provisions of Part 18 shall apply to exits from Group B buildings.

SECTION 406. *Aisles and Seating.* — (a) Aisles having seats on both sides shall be not less than thirty

inches in width at the end remote from an exit and shall be widened by two inches for each ten feet in length measured toward the exit. Aisles having seats on one side only shall be not less than twenty-four inches wide at the end remote from an exit, and shall be widened toward the exit by two inches for each ten feet in length. Side aisles serving more than one exit shall be of uniform width between exits and such width shall be not less than that required by this paragraph at a point midway between the extreme exits.

(b) Aisles shall be so arranged that not more than six seats shall intervene between any seat and the nearest aisle.

(c) There shall be no obstructions of any kind in an aisle. Aisles on the main floor and in balconies may be sloped or stepped. When sloped, the slope shall not exceed two inches vertical in ten inches horizontal. When stepped the rise shall not exceed twenty-one inches in a horizontal distance of thirty-two inches. Stepped aisles shall not be construed to be stairways.

(d) Auditorium main floors having more than thirty-five rows of seats shall have a cross aisle leading from the center aisle or aisles to the side aisles. Balconies shall have a cross aisle for every twenty rows of seats and fraction of twenty, such cross aisle to run from side to side of the auditorium. Cross aisles shall be not less than three feet wide in the clear and shall lead to exits that are easily accessible. Vomitories shall be considered entrances and exits.

(e) Seats shall be spaced not less than thirty-two inches except that fixed seats with backs less than one inch thick may be spaced not less than thirty

inches back to back. Seats in stepped balconies shall be spaced not less than thirty-two inches back to back. No seats shall be less than eighteen inches in width center to center.

(f) In a hall or balcony seating more than one hundred and fifty persons, seats shall be fastened to the floor or adequate means, by cleats or otherwise, shall be provided so that the relative position of seats shall be maintained. In smaller halls or balconies, unless the seats are so secured, the aisles shall be four inches wider than as provided in paragraph (a) of this section.

SECTION 407. *Exit Lights.*—Over every exit doorway, on the inside, there shall be an illuminated sign bearing the word "EXIT" in letters not less than four inches high. Each sign shall be provided with two electric lamps.

SECTION 408. *Light and Ventilation.*—(a) Assembly halls, foyers, toilet rooms and other public rooms shall be provided with light and ventilation by means of windows or skylights with an aggregate area not less than one eighth the floor area in each room, or they shall be provided with artificial light and a mechanically operated ventilating system. The mechanically operated ventilating system shall provide for four complete changes of air per hour, and in assembly halls shall supply at least fifteen cubic feet of fresh air per minute for each occupant thereof. If the velocity of the air entering the room exceeds five feet per second, the opening must be placed more than eight feet above the floor directly

beneath. Adequate means shall be provided for the removal of foul air.

(b) Registers or ventilating ducts for supplying air to or exhausting air from stages shall be equipped with automatic-closing shutters with fusible links.

(c) Lights for stages shall be on circuits separate from the lights of the remainder of the building. Lights in corridors, stairways, and other parts of exits shall be suitably protected.

(d) In an assembly hall having a seating capacity in excess of eight hundred the exit sign lights and selected lamps in foyers, auditoriums, stairways, corridors and other paths of exit therefrom sufficient to provide illumination for egress in case of emergency shall be wired on a separate emergency circuit with a second source of current as provided for in Group A occupancy. Exit sign lights shall be kept lighted when the hall is occupied, and other emergency lights, except auditorium lights, when the hall is occupied except before sunset in rooms, corridors and stairways sufficiently lighted by windows.

SECTION 409. *Stage and Proscenium.* — (a) Where a stage or platform is without provisions for scenery, no separation from the auditorium shall be required, and such stage or platform may be of the same type of construction as the auditorium floor; or it may be constructed of wood, if the auditorium floor extends under the full area of such stage or platform.

(b) Where a stage has provisions for standing scenery only, such stage shall be separated from the auditorium by a proscenium wall of not less than two-hour fire-resistive construction. Each opening

through this wall, other than the proscenium opening, shall not exceed twenty-five square feet in area, and shall be protected by a Class A fire door. Where such stage exceeds fifteen feet in depth, or where the proscenium opening exceeds twenty-five feet in width or twelve feet in height, the proscenium opening shall be provided with a proscenium curtain as specified for theatres in Part 3. Where such stage is less than fifteen feet in depth, and the proscenium opening is less than twenty-five feet in width and twelve feet in height, the proscenium curtain shall be either of asbestos fabric or of cotton or other fabric flame-proofed by approved chemical process.

**SECTION 410. *Dressing Rooms, Workshops and Boiler Rooms.***—Dressing rooms, workshops and store rooms near the stage shall be separated therefrom by a two-hour separation as defined in Part 13. Every boiler room or room containing a heating plant shall be separated from the rest of the building by a two-hour separation.

**SECTION 411. *Fire-Extinguishing Apparatus.***—  
(a) Portions of cellars and basements not used by the public, stages with proscenium walls, dressing rooms, store rooms and property rooms shall be equipped with automatic sprinklers. Attics, the space under stages and other such spaces, if available for storage, shall be equipped with automatic sprinklers.

(b) In every assembly hall seating more than fifteen hundred, a proscenium opening required to have a curtain as specified for theatres, shall also be equipped with a water curtain as specified in Part 3.

(c) A portable fire extinguisher of approved type shall be provided outside of every projection room near the door.

(d) In buildings more than two stories high, either portable extinguishers, not less than one for every two thousand square feet of floor area, or first aid standpipes, shall be provided in spaces other than projection rooms, but first aid standpipes shall not be provided in assembly halls, corridors, foyers, exits and other rooms used by persons assembled in such halls.

(e) Fire department standpipes and first aid standpipes shall be provided in buildings more than seventy feet high.

SECTION 412. *Projection Room.*—A projection room shall have a floor of granolithic, tile or terrazzo supported on a concrete base not less than three inches in total thickness which may be supported by a floor of the same type of construction as that of the building, or of other materials having equivalent fire-resistance. A projection room shall have walls and ceiling of not less than one-hour fire-resistive construction of incombustible materials. In other respects a projection room shall conform to the requirements of sections seventy-two to eighty-eight, inclusive, of chapter one hundred and forty-three of the General Laws, and to the regulations established thereunder by the commissioner of public safety of the commonwealth of Massachusetts.

## PART 5.

SPECIAL REQUIREMENTS FOR GROUP C OCCUPANCY:  
SCHOOLS.

## SECTION

- 501 — Group C Occupancy: Type, Height, Area.
- 502 — Separation of Occupancies.
- 503 — Exterior Walls.
- 504 — Enclosure of Vertical Openings.
- 505 — Exits.
- 506 — Aisles and Seating.
- 507 — Light.
- 508 — Ventilation and Heating.
- 509 — Fire-Extinguishing Apparatus.
- 510 — Special Requirements.
- 511 — Toilet Accommodations.

SECTION 501. *Group C Occupancy: Type, Height, Area.* — (a) Group C shall include every building used wholly or in part as a school.

(b) Buildings or parts of buildings classified for occupancy in Group C shall be limited as to type of construction, height and area of units, as follows:—

TYPE OF CONSTRUCTION.	HEIGHT.		Maximum Area of Unit (Square Feet).
	Feet.	Stories.	
I . . . . . . . .	Not hereby limited		Not hereby limited
II . . . . . . . .	55	4	18,000
	55	1	24,000
III . . . . . . . .	35	2	17,000
	35	1	20,000
IV . . . . . . . .	35	2	12,000
	35	1	18,000
V . . . . . . . .	35	1	10,000
VI . . . . . . . .	35	1	5,000

The maximum area may be increased proportionately within the limits given as the number of stories is decreased from the maximum.

(c) The maximum area provided in this section may be increased fifty per cent if the entire floor area is protected by automatic sprinklers.

(d) Assembly halls with seating capacity of more than one hundred and fifty persons shall conform with the requirements of Part 4 and, in addition, the capacity of exits shall be computed in multiples of twenty inches of the width thereof.

(e) Every Group C building in the first or second fire zone shall be of Type I or Type II construction.

**SECTION 502. *Separation of Occupancies.*** — Group C occupancies shall be separated from other occupancies, and fire divisions of Group C occupancy shall be separated from adjoining fire divisions as specified in Part 13.

**SECTION 503. *Exterior Walls.*** — (a) Exterior walls or parts of walls, except where fronting on a street, which are less than five feet from a property line, shall be of four-hour fire-resistive construction without openings. Such walls or parts of walls which are five feet or more, but less than ten feet from a property line, shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows.

(b) Every portion of an exterior wall which faces, at a distance of less than twenty feet, the further side of a street, or a combustible wall or roof, or an unprotected opening in a wall or roof of another building on the same lot, shall be of at least two-hour

fire-resistive construction, and all openings in such portions shall be protected by Class B fire doors or fire windows.

(c) The commissioner may waive the requirements of this section, for protection or prohibition of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds for Suffolk county to comply with the said requirements on demand of the commissioner.

(d) In buildings of Type V construction, exterior walls of unprotected metal may be considered to meet the requirements of this section for two-hour walls.

SECTION 504. *Enclosure of Vertical Openings.* —

(a) Elevator shafts, ventilating shafts, dust chutes and other vertical openings, except stairways and ramps, shall be enclosed.

(b) Stairways and ramps in buildings of Type I or Type II not over three stories high need not be enclosed from corridors in the first, second or third story. Other stairways and ramps which pierce only one floor shall be enclosed in the story above or below, but such stairways or ramps which serve as required exits from one story shall be enclosed in the other story. Other stairways and ramps shall be enclosed in all stories in which they occur.

SECTION 505. *Exits.* — (a) All rooms for pupils shall have at least one exit opening into a corridor. Rooms accommodating more than forty-five pupils shall have two remote exits, one of which shall, and both of which may open into a corridor. The other exit may lead through an adjoining room or passage-

way. The exit to the corridor shall preferably be near the teacher's end of the room. The width of an exit shall be not less than forty inches nor less than twenty inches for each one hundred persons or fraction thereof served by and allotted to an exit.

(b) Corridors shall have uniform width between exits and shall have a clear exit-width not less than six feet, nor less than twenty inches for each one hundred persons or fraction thereof allotted to it as a path of exit; provided, that the exit-width of a corridor shall not be required to exceed ten feet. If classroom doors on one or both sides of a corridor project into it when in open position, the width of the corridor shall be increased over its required exit-width by one half the sum of such projections. If lockers are installed in the walls of corridors on one or both sides, the width of the corridor shall be increased over its required exit-width by eighteen inches for each side on which lockers are installed. No obstruction shall be placed in corridors except that the drip of a recessed drinking fountain or a radiator may project into a corridor. If a radiator less than six feet six inches above the floor is placed in a path of exit and is not fully recessed, the width of the corridor shall be measured from the face of the radiator.

(c) Each corridor shall have at least two remote exits which shall be exits from the story as specified in Part 18. Such exits shall be so located that every doorway from a room for pupils to a corridor shall be not more than seventy feet from an exit from the corridor. The persons in each room having an exit to a corridor shall be allotted to a path of exit through the corridor to the nearest exit therefrom for the

purpose of computing the width of corridors and their exits; provided, that if the mid-length point of a corridor between its exits lies in an exit from a room or between two exits from a room, the persons in such room may be allotted to either exit from the corridor. The width of every exit from a corridor shall be not less than forty inches, nor less than twenty inches for each one hundred persons or fraction thereof allotted to it.

(d) Each story of a Group C building shall have at least two remote exits. The width of stairs and ramps and of exits from them shall be not less than forty inches nor less than twenty inches for each one hundred persons or fraction thereof allotted to them and shall be based upon the largest number of persons from any one story whom they serve as exits. If doors in exit doorways more than four feet wide have latches, such latches shall be panic bolts or similar devices of non-corrodible material.

(e) All stairways or ramps serving as required exits shall be enclosed in all stories, except that they need not be enclosed from corridors in the first, second and third stories of buildings of Type I and Type II not over three stories high, and doorways in such enclosures shall have one-way swinging, self-closing doors opening in the direction of egress.

(f) No intake for a dust or waste paper chute shall open directly upon a corridor or enclosed exit, but may open in a closet off a corridor.

(g) All stairs shall have a handrail on each side. Stairs eighty inches or more in width shall have one or more intermediate rails dividing the stairs into widths less than eighty inches but not less than forty inches; provided, that in calculating the capacity

as an exit of a stair so divided, each division shall be considered an exit. The upper ends of handrails shall be returned to the wall or shall so terminate at a post as not to leave a free or projecting end.

(h) Stair landings shall have a width at least equal to that of the stairs. No run of stairs shall have more than fifteen nor less than three risers. The rise shall not exceed seven and one half inches nor shall the tread be less than ten inches. Winders shall not be permitted.

SECTION 506. *Aisles and Seating.*—(a) Classrooms with fixed seats shall have aisles at least thirty inches wide next to the windows and at least thirty-six inches wide on other sides, and intermediate aisles at least sixteen inches wide.

(b) Unless definitely fixed on the plans the normal seating capacity of classrooms shall be determined by dividing the floor area of each room as follows:—

Elementary Schools	by 15 square feet
Intermediate Schools	by 17 square feet
High Schools and Colleges	by 19 square feet

SECTION 507. *Light.*—(a) Rooms used by pupils for study and class work shall have outside windows with a total sash area not less than one fifth the floor area of each such room. The windows shall preferably be on the long side of a room and the width of a room shall not be more than twice the clear height. No room shall be used for class work where an exterior wall outside and opposite the required windows shall extend above a line from the window sills at thirty degrees above the horizontal unless such wall is at least sixty feet from the win-

dows. The possibility of a building on an adjoining lot shall be provided for.

(b) Toilet rooms for pupils, locker and lunch rooms shall have outside windows or skylights the aggregate area of which shall be not less than one eighth the floor area of each such room.

(c) Corridors, stairways and other exits shall have artificial illumination which, if electric, shall be on circuits and control separate from other lighting in the building.

SECTION 508. *Ventilation and Heating.* — (a) In all rooms used by pupils for school purposes shall be installed a positive system of ventilation that will supply fresh air, heated when necessary, and adequately remove the foul air. In class, recitation and study rooms there shall be provided at least six complete air changes per hour but not less than twenty cubic feet of fresh air per minute per pupil normally seated, and in assembly rooms, gymnasiums, lunch rooms and vocational rooms at least four complete changes of air per hour but not less than fifteen cubic feet per minute per pupil for whom seating or work space is provided. In toilets, shower and locker rooms at least eight complete air changes per hour shall be provided and these rooms shall be ventilated by an exhaust system.

(b) The heating and ventilating system shall be capable of maintaining, when the outside temperature is zero, in gymnasiums and toilets a temperature of sixty degrees, in shower and locker rooms appurtenant to gymnasiums seventy-five degrees, and in other rooms used by pupils or teachers seventy degrees, all by Fahrenheit scale.

SECTION 509. *Fire-Extinguishing Apparatus.* —

(a) Cellars and basements, except those portions used for classes, shall be equipped with automatic sprinklers. Mechanical trade shops, storage rooms and attics available for storage shall have automatic sprinklers where required by the commissioner.

(b) A portable fire-extinguisher of approved type shall be provided outside of every projection room near the door.

(c) In buildings more than two stories high, either portable fire-extinguishers, not less than one for every thirty-five hundred square feet of floor area and not less than one in each story, or first aid standpipes shall be provided, but first aid standpipes shall not be provided in assembly halls or in exits therefrom.

(d) Fire department standpipes and first aid standpipes shall be provided in buildings more than seventy feet high.

SECTION 510. *Special Requirements.* — Every boiler room shall be separated from the remainder of the building by a two-hour separation as specified in Part 13.SECTION 511. *Toilet Accommodations.* — (a) Adequate toilets shall be provided for pupils, with fixtures in accordance with the following table: —

NUMBER OF PUPILS OF EITHER SEX.	GIRLS.		BOYS.	
	Water Closets.		Water Closets.	Urinals.
50 . . . . . . . .	4		3	4
100 . . . . . . . .	6		4	6
150 . . . . . . . .	9		6	8
200 . . . . . . . .	12		8	10
250 . . . . . . . .	14		9	12
300 . . . . . . . .	16		10	14
350 . . . . . . . .	18		11	16
400 . . . . . . . .	20		12	18
450 . . . . . . . .	22		13	20
500 . . . . . . . .	24		14	22
1,000 . . . . . . . .	43		25	40
1,500 . . . . . . . .	61		36	56

(b) For intermediate numbers of pupils, fixtures shall be provided by interpolation in the table and for numbers in excess of fifteen hundred at the rate provided for fifteen hundred.

(c) Separate toilets shall be provided for the teachers and for the janitors.

## PART 6.

### SPECIAL REQUIREMENTS FOR GROUP D OCCUPANCY: HOSPITALS AND DETENTION BUILDINGS.

#### SECTION

- 601 — Group D Occupancy: Type, Height, Area.
- 602 — Separation of Occupancies.
- 603 — Exterior Walls.
- 604 — Enclosure of Vertical Openings.
- 605 — Exits.
- 606 — Light and Ventilation.
- 607 — Fire-Extinguishing Apparatus.
- 608 — Special Requirements.
- 609 — Exceptions.

SECTION 601. *Group D Occupancy: Type, Height, Area.* — (a) Group D shall include such occupancies as —

*Division 1.* Jails, prisons, reformatories, houses of correction, asylums for the insane or feeble minded, the parts of police stations wherein more than ten persons may be detained, and similar buildings.

*Division 2.* Hospitals, sanitariums, orphanages, nurseries, homes for the aged and similar buildings, with sleeping accommodations for ten or more persons.

(b) Buildings or parts of buildings classified for occupancy in Group D shall be limited as to type of construction, height and area of units, as follows:—

TYPE OF CONSTRUCTION.	HEIGHT.		Maximum Area of Unit (Square Feet).
	Feet.	Stories.	
I . . . . . . . . . .	Not hereby limited		Not hereby limited
II . . . . . . . . . .	55	4	17,000
	55	1	20,000
III . . . . . . . . . .	45	3	12,000
	35	1	18,000
IV . . . . . . . . . .	45	3	10,000
	35	1	15,000
V . . . . . . . . . .	35	1	7,500
VI . . . . . . . . . .	35	1	2,500

The maximum area may be increased proportionately within the limits given as the number of stories is decreased from the maximum.

(c) Division 1 buildings of Group D shall be of Type I construction throughout. The ceilings and partitions of Division 2 buildings of Group D more than one story in height shall be of not less than one-hour fire-resistive construction and the first floor of

such buildings more than two stories in height shall be of Type I construction.

(d) The provisions of this section and of Part 16 shall not be held to prohibit cell block mezzanine floor construction of unprotected metal without limitation as to number and area of such floors provided the entire cell block construction is of combustible materials.

SECTION 602. *Separation of Occupancies.* — Group D occupancies shall be separated from other occupancies, and fire divisions of Group D occupancy shall be separated from adjoining fire divisions as specified in Part 13.

SECTION 603. *Exterior Walls.* — (a) Exterior walls or parts of walls, except where fronting on a street, which are less than five feet from a property line, shall be of four-hour fire-resistive construction without openings, except that openings in such walls at the ends of courts shall be allowed when protected by Class B fire doors or fire windows. Such walls or parts of walls which are five feet or more, but less than ten feet from a property line shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows.

(b) Every portion of an exterior wall which faces, at a distance of less than twenty feet, the further side of a street, or a combustible wall or roof, or an unprotected opening in a wall or roof of another building on the same lot, shall be of at least two-hour fire-resistive construction, and all openings in such

portions shall be protected by Class B fire doors or fire windows.

(c) The commissioner may waive the requirements of this section, for protection or prohibition of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds for Suffolk county to comply with the said requirements on demand of the commissioner.

(d) In buildings of Type V construction exterior walls of unprotected metal may be considered to meet the requirements of this section for two-hour walls.

SECTION 604. *Enclosure of Vertical Openings.* —

(a) Elevator shafts, ventilating shafts and other vertical openings, except stairways and ramps, shall be enclosed.

(b) Stairways and ramps which pierce only one floor shall be enclosed in the story above or below but such a stairway or ramp which serves as required exit from one story shall be enclosed in the other story. Other stairways and ramps shall be enclosed in all stories in which they occur.

(c) This section and Part 15 shall not be held to require enclosure of mezzanine floors in Group D buildings nor of vertical openings in such floors, nor of cell block floors if such cell blocks are constructed entirely of incombustible materials.

SECTION 605. *Exits.* — (a) Every portion of a building shall be provided with exits as specified in Part 18.

(b) In buildings of Division 2 exits from a story, as specified in Part 18, shall be so located that no

bed shall be more than seventy feet distant from at least one such exit measured along the path of exit.

(c) In buildings of Division 2 exit doorways from patients' rooms shall be not less than thirty-six inches wide. In such buildings corridors, stairways, ramps, doorways in stair or ramp enclosures and doorways from the building, which serve as required exits, shall be not less than forty-four inches wide. In such stairways the tread shall not be less than eleven inches nor the rise more than six and one half inches; stair landings at turns shall be not less than sixty inches wide.

(d) Except in places of detention, exit doors shall not be fastened against egress except by self-releasing latches, panic-bolts or similar devices which can readily be opened from the inside at all times without the use of keys or any special knowledge or effort. Revolving doors shall not be installed in required exit doorways from buildings of Group D occupancy.

SECTION 606. *Light and Ventilation.* — Rooms ordinarily occupied by human beings, shall be provided with light and ventilation by means of windows or skylights, the area of which shall be not less than one eighth of the floor area, or by a mechanically operated ventilating system supplying at least fifteen cubic feet of fresh air per minute per occupant or four complete changes of air per hour, whichever is greater.

SECTION 607. *Fire-Extinguishing Apparatus.* — (a) All cellars, basements and shafts shall be protected by automatic sprinklers. Store rooms, kitchens and utility rooms in buildings of other

than Type I or Type II construction shall be protected by automatic sprinklers.

(b) In all buildings either portable fire extinguishers, not less than one for every twenty-five hundred square feet of floor area and at least one in each story, or first aid standpipes shall be provided.

(c) Fire department standpipes and first aid standpipes shall be provided in buildings more than seventy feet high.

SECTION 608. *Special Requirements.* — (a) Every gas service shall have a shut-off easily accessible from the outside and conspicuously marked.

(b) Every boiler room or room containing heating apparatus shall be separated from the rest of the building with a three-hour fire separation, as specified in Part 13.

SECTION 609. *Exceptions.* — No requirement of this chapter shall be so construed as to prohibit the construction of cells in jails or prevent the use of locks or safety devices in buildings where it is necessary forcibly to restrain the inmates.

## PART 7.

### SPECIAL REQUIREMENTS FOR GROUP E OCCUPANCY: COMMERCIAL BUILDINGS OF HAZARDOUS OCCUPANCY.

#### SECTION

- 701 — Group E Occupancy: Type, Height, Area.
- 702 — Separation of Occupancies.
- 703 — Exterior Walls.
- 704 — Enclosure of Vertical Openings.
- 705 — Exits.
- 706 — Light and Ventilation.
- 707 — Fire-Extinguishing Apparatus.
- 708 — Special Hazards.

**SECTION 701. Group E Occupancy: Type, Height, Area.** — (a) Group E shall include such occupancies as —

*Division 1.* Garages of more than six cars capacity and hangars.

*Division 2.* Planing mills, box factories, wood working plants, mattress factories, paint shops and dry cleaning plants.

*Division 3.* Buildings for the storage of hazardous, highly flammable or explosive material or liquids.

(b) Buildings or parts of buildings classified for occupancy in Group E shall be limited as to type of construction, height and area of units, as follows: —

TYPE OF CONSTRUCTION.	HEIGHT.		MAXIMUM AREA OF UNIT IN SQUARE FEET ACCESSIBLE FROM —		
	Feet.	Stories.	One Side.	Two Sides.	Three Sides.
I . . . . .	150	15	10,000	15,000	20,000
II . . . . .	50	4	8,000	10,000	12,000
III . . . . .	50	4	8,000	10,000	12,000
IV . . . . .	40	3	4,000	6,000	8,000
	20	1	6,000	8,000	10,000
V . . . . .	20	1	6,000	8,000	10,000
VI . . . . .	20	1	3,000	4,000	5,000

The maximum area of Type IV units may be increased proportionately within the limits given as the number of stories is decreased from the maximum.

(c) The limitations upon area of the foregoing table shall not apply to buildings one story high of Division 1, of Type I construction, the units of which may have areas not in excess of fifteen thousand, twenty thousand and twenty-five thousand square feet, if accessible from one, two or three sides, respectively.

SECTION 702. *Separation of Occupancies.*—Group E occupancies shall be separated from other occupancies, and fire divisions of Group E occupancy shall be separated from adjoining fire divisions as specified in Part 13. Two tenants shall be separated by partitions of at least one-hour and, in a basement, at least two-hour fire-resistive rating.

SECTION 703. *Exterior Walls.*—(a) Exterior walls or parts of walls, except where fronting on a street, which are less than five feet from a property line, shall be of four-hour fire-resistive construction without openings, except that openings in such walls at the ends of courts shall be allowed when protected by Class B fire doors or fire windows. Such walls or parts of walls which are five feet or more, but less than ten feet from a property line, shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows.

(b) Every portion of an exterior wall which faces, at a distance of less than twenty feet, the further side of a street, or a combustible wall or roof, or an unprotected opening in a wall or roof of another building on the same lot, shall be of at least two-hour fire-resistive construction, and all openings in such portions shall be protected by Class B fire doors or fire windows.

(c) The commissioner may waive the requirements of this section, for protection or prohibition of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds for Suffolk county to comply with the said requirements on demand of the commissioner.

(d) In buildings of Type V construction exterior walls of unprotected metal may be considered to meet the requirements of this section for two-hour walls.

**SECTION 704. *Enclosure of Vertical Openings.* —**

(a) Elevator shafts, ventilating shafts and other vertical openings except stairways and ramps shall be enclosed.

(b) Mezzanine floors shall be enclosed when otherwise the total floor area in one story exposed to a single fire would exceed the maximum area of unit specified in section seven hundred and one. Vertical openings in enclosed mezzanine floors shall be enclosed as herein provided for other floors.

(c) Ramps which are used for the movement of automobiles from one story to another, or for a similar purpose, shall be enclosed or shall be provided with automatic-closing Class A fire doors which will serve as a fire stop between stories. A ramp with such doors shall not be counted as a required exit.

(d) Doors which are part of an automobile ramp enclosure may be kept normally open but shall be so equipped as to close automatically in case of fire.

(e) Stairways and ramps other than for automobiles, which pierce only one floor, shall be enclosed in the story above or below but such stairways or ramps, which serve as required exits from one story, shall be enclosed in the other story. Other stairways shall be enclosed in all stories in which they occur.

**SECTION 705. *Exits.* — (a) Every portion of a building shall be provided with exits as specified in Part 18.**

- (b) Exits from every story shall be so located that no point within the story shall be further than one hundred feet from the nearest exit.
- (c) Doorways serving as exits from rooms into a stair or ramp enclosures shall have one-way swinging self-closing doors opening in the direction of egress.

SECTION 706. *Light and Ventilation.* — (a) Rooms used by human beings shall be provided with light and ventilation by means of windows or skylights with an area at least one eighth of the floor area or shall be provided with artificial light and a mechanically operated ventilating system providing not less than four complete changes of air per hour or fifteen cubic feet of air per minute for each occupant, whichever is greater.

(b) In all portions of buildings used for the storing or handling of automobiles operated under their own power and in all portions of buildings where flammable liquids are used, either direct ventilation by means of vent holes at the floor level not less than sixteen square inches in area placed not more than sixteen feet apart, protected by metal screens, and opening directly to the outside air, or their equivalent, or mechanical exhaust ventilation sufficient to produce four complete changes of air per hour, shall be provided. Such exhaust ventilation shall be taken from points at or near the floor level.

SECTION 707. *Fire-Extinguishing Apparatus.* — (a) Automatic sprinklers shall be installed in the following locations: —

(1) Throughout every unit of occupancy higher than two stories or having an aggregate floor area greater than ten thousand square feet.

(2) In cellars and basements of which the floor area is more than fifteen hundred square feet.

(3) Throughout a building which is occupied wholly or in part as a planing mill, box factory, or other wood working establishment, in which more than two power-operated wood working machines, other than saws, are used.

(4) Throughout a building which is occupied wholly or in part as a mattress factory or used to manufacture, assemble or renovate mattresses or stuffed furniture using cotton, silk floss, mohair or other like material for packing or stuffing.

(5) In a building used as a film exchange, or for the manufacture or storage of nitro-cellulose pyroxylin products.

(b) Portable fire-extinguishers, not less than one for every two thousand square feet of floor area and at least one in each story, or first aid standpipes shall be provided, except as required by chapter one hundred and forty-eight of the General Laws and regulations issued thereunder.

(c) Fire department standpipes and first aid standpipes shall be provided in every building more than seventy feet high.

SECTION 708. *Special Hazards.* — (a) Neither apparatus having an open flame nor a heater with an enclosed flame shall be installed or operated in a garage, dry cleaning establishment or place where volatile flammable liquids are used or stored, unless approved by the state fire marshal.

(b) Rooms in which volatile flammable liquids are used or stored shall be enclosed with partitions of not less than one-hour fire-resistive construction as

specified in Part 22. Doorways in such partitions shall have Class C fire doors so equipped as to close automatically in case of fire.

(c) In a dry cleaning establishment each machine which uses a volatile flammable liquid shall have an adequate steam line directly connected to it, so arranged as automatically to fill the machine with steam in case of fire or explosion therein.

(d) In public garages, dry cleaning establishments and other buildings in which volatile flammable liquids are used, sold or stored;

(1) Type VI construction shall not be used;

(2) Type IV construction shall not be used more than two stories in height or over six hundred square feet in area.

(e) Garages, hangars and rooms in which paint, petroleum or other flammable liquids are used or stored otherwise than in unopened containers shall have non-absorbent, incombustible floor finish.

## PART 8.

### SPECIAL REQUIREMENTS FOR GROUP F OCCUPANCY: OFFICES AND COMMERCIAL BUILDINGS.

#### SECTION

801 — Group F Occupancy: Type, Height, Area.

802 — Separation of Occupancies.

803 — Exterior Walls.

804 — Enclosure of Vertical Openings.

805 — Exits.

806 — Light and Ventilation.

807 — Fire-Extinguishing Apparatus.

SECTION 801. *Group F Occupancy: Type, Height, Area.* — (a) Group F shall include such occupancies as —

*Division 1.* Office buildings, restaurants, police and fire stations, museums and libraries.

*Division 2.* Wholesale and retail stores, printing plants, factories and work shops using materials not highly flammable.

*Division 3.*—Buildings for the storage or sale of goods not highly flammable, stables and buildings not on wharves for the storing or handling of transient freight.

*Division 4.* Wharf buildings for the storage or handling of transient freight.

(b) Buildings or parts of buildings classified for occupancy in Group F except those in Division 4 thereof, shall be limited as to type of construction, height and area of units, as follows:—

TYPE OF CONSTRUCTION.	HEIGHT.		MAXIMUM AREA OF UNIT IN SQUARE FEET ACCESSIBLE FROM—		
	Feet.	Stories.	One Side.	Two Sides.	Three Sides.
I . . . . .	Not hereby limited		Not hereby limited		
II . . . . .	80	7	10,000	12,000	15,000
III . . . . .	75	6	9,000	10,000	12,000
IV . . . . .	55	5	4,000	6,000	8,000
	35	3	6,000	8,000	10,000
V . . . . .	35	2	6,000	8,000	10,000
VI . . . . .	30	2	3,000	4,000	5,000

The maximum area of Type IV units may be increased proportionately within the limits given as the number of stories is decreased from the maximum.

(c) The portions of police stations in which not more than ten persons may be detained shall be constructed of incombustible materials and shall be separated from the remainder of the building, if of combustible materials, by a two-hour fire-resistive separation.

(d) Buildings on wharves, used for storage other than that which is incidental to handling water-borne freight, or used for manufacturing or any purpose other than such handling, shall be classified in an occupancy group according to such use, disregarding their location on wharves. Buildings on wharves of pile or other open construction over water, or of filled construction behind retaining walls or bulkheads, beside docks wherein vessels may be moored, used for handling, namely for assembling, loading, discharging and sorting water-borne freight, or for passengers, and of the several types of construction shall not exceed in height and area of units of occupancy the following limits:—

TYPE OF CONSTRUCTION.	HEIGHT.		Maximum Area of Unit (Square Feet).
	Feet.	Stories.	
I . . . . . . . . .	Not hereby limited		Not hereby limited
II . . . . . . . . .	50 to 80	3 to 7	15,000
	50	2	120,000
III . . . . . . . . .	50 to 75	3 to 6	12,000
	50	2	60,000
IV . . . . . . . . .	50 to 55	3 to 5	10,000
	50	2	60,000
V . . . . . . . . .	35	2	60,000
VI . . . . . . . . .	30	2	30,000

(e) In buildings on wooden wharves, such units of occupancy shall not exceed twenty thousand square feet in area.

(f) The maximum areas provided in this section for buildings of Division 1, and for buildings of Divisions 2 and 3 less than six stories in height, may be increased fifty per cent if the entire floor area is protected with automatic sprinklers.

SECTION 802. *Separation of Occupancies.*—Group F occupancies shall be separated from other occupancies, and fire divisions of Group F occupancy shall be separated from adjoining fire divisions as specified in Part 13. Two tenants shall be separated by partitions of at least one-hour and, in a basement, at least two-hour fire-resistive rating.

SECTION 803. *Exterior Walls.*—(a) Exterior walls or parts of walls, except where fronting on a street, which are less than ten feet from a property line, shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows.

(b) Every portion of an exterior wall which faces, at a distance of less than twenty feet, the further side of a street, or a combustible wall or roof, or an unprotected opening in a wall or roof of another building on the same lot, shall be of at least two-hour fire-resistive construction, and all openings in such portions, except doorways and windows in the first story fronting on a public way, shall be protected by Class B fire doors or fire windows.

(c) The commissioner may waive the requirements of this section, for protection of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds for Suffolk county to comply with the said requirements on demand of the commissioner.

(d) In buildings of Type V construction exterior walls of unprotected metal may be considered to meet the requirements of this section for two-hour walls.

SECTION 804. *Enclosure of Vertical Openings.*—

(a) Elevator shafts, ventilating shafts and other vertical openings except stairways and ramps, shall be enclosed.

(b) Ramps for the movement of freight shall be enclosed as specified in Part 15 or shall be provided with automatic-closing Class A fire doors which will serve as a fire stop between stories. A ramp with such doors shall not be counted as a required exit.

(c) In buildings of Division 1 and in retail stores, stairways and ramps, other than for freight, serving only basements, first and second stories, need not be enclosed. Exit stairways and ramps which pierce only one floor, except as provided in the preceding sentence, shall be enclosed in the story above or below. Other exit stairways and ramps shall be enclosed in all stories in which they occur.

(d) This section shall not be held to require enclosure of mezzanine floors nor of vertical openings in such floors. The provisions of this section shall not apply to book stacks of incombustible material in libraries of Type I or Type II construction.

SECTION 805. *Exits.*—Every portion of a Group F building except library book stacks three levels or less in height shall be provided with exits as specified in Part 18.SECTION 806. *Light and Ventilation.*—Rooms used by human beings shall be provided with light and ventilation by means of windows or skylights with an area at least one eighth of the floor area or shall be provided with artificial light and a mechanically operated ventilating system providing not less

than four complete changes of air per hour or fifteen cubic feet of air per minute for each occupant, whichever is greater.

**SECTION 807. *Fire-Extinguishing Apparatus.* —**

(a) Automatic sprinklers shall be installed in cellars and basements of which the floor area is more than fifteen hundred square feet.

(b) Buildings of Divisions 2 and 3, six or more stories in height shall be equipped throughout with automatic sprinklers.

(c) Buildings of Division 4 of Type III, Type IV or Type VI construction or on wooden wharves, more than five thousand square feet in area of units, and buildings of Type I, Type II or Type V construction on incombustible wharves, more than twenty thousand square feet in area, shall be protected by automatic sprinklers.

(d) In buildings more than two stories high either portable fire-extinguishers, not less than one for every twenty-five hundred square feet of floor area and at least one in each story, or first aid standpipes, shall be provided.

(e) Fire department standpipes and first aid standpipes shall be provided in buildings more than seventy feet high.

## PART 9.

SPECIAL REQUIREMENTS FOR GROUP G OCCUPANCY:  
 COMMERCIAL BUILDINGS OF NON-HAZARDOUS  
 OCCUPANCY.

## SECTION

- 901 — Group G Occupancy: Type, Height, Area.
- 902 — Separation of Occupancies.
- 903 — Exterior Walls.
- 904 — Enclosure of Vertical Openings.
- 905 — Exits.
- 906 — Light and Ventilation.
- 907 — Fire-Extinguishing Apparatus.

SECTION 901. *Group G Occupancy: Type, Height, Area.* — (a) Group G shall include such occupancies as —

*Division 1.* Ice, power and pumping plants, cold storage rooms and plants, creameries, breweries and other similar buildings.

*Division 2.* Factories and workshops using incombustible and non-explosive materials.

*Division 3.* Buildings for the storage or sale of incombustible and non-explosive materials.

(b) Buildings or parts of buildings classified for occupancy in Group G shall be limited as to type of construction, height and area of units, as follows:—

TYPE OF CONSTRUCTION.	HEIGHT.		MAXIMUM AREA OF UNIT IN SQUARE FEET ACCESSIBLE FROM —		
	Feet.	Stories.	One Side.	Two Sides.	Three Sides.
I . . . . .	Not hereby limited		Not hereby limited		
II . . . . .	80	7	15,000	18,000	20,000
III . . . . .	75	6	15,000	18,000	20,000
IV . . . . .	55	5	8,000	10,000	12,000
	40	3	10,000	12,000	14,000
V . . . . .	35	2	10,000	12,000	14,000
VI . . . . .	30	2	3,000	4,000	5,000

The maximum area of Type IV units may be increased proportionately within the limits given as the number of stories is decreased from the maximum.

SECTION 902. *Separation of Occupancies.*—Group G occupancies shall be separated from other occupancies, and fire divisions of Group G occupancy shall be separated from adjoining fire divisions as specified in Part 13.

SECTION 903. *Exterior Walls.*—(a) Exterior walls or parts of walls, except where fronting on a street, which are less than ten feet from a property line, shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows.

(b) Every portion of an exterior wall which faces, at a distance of less than twenty feet, the further side of a street, or a combustible wall or roof, or an unprotected opening in a wall or roof of another building on the same lot, shall be of at least two-hour fire-resistive construction, and all openings in such portions shall be protected by Class B fire doors or fire windows.

(c) The commissioner may waive the requirements of this section, for protection of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds for Suffolk county to comply with the said requirements on demand of the commissioner.

(d) In buildings of Type V construction exterior walls of unprotected metal may be considered to meet the requirements of this section for two-hour walls.

SECTION 904. *Enclosure of Vertical Openings.* —

(a) Elevator shafts, ventilating shafts, and other vertical openings, except stairways and ramps shall be enclosed.

(b) Ramps for the movement of freight shall be enclosed as specified in Part 15 or shall be provided with automatic-closing Class A fire doors which will serve as a fire stop between stories. A ramp with such doors shall not be counted as a required exit.

(c) Stairways and ramps other than for freight which pierce only one floor shall be enclosed in the story above or below but such stairways or ramps which serve as required exits from one story shall be enclosed in the other story. Other stairways and ramps shall be enclosed in all stories in which they occur.

(d) This section shall not be held to require enclosure of mezzanine floors nor of vertical openings in such floors.

SECTION 905. *Exits.* — Every portion of a building shall be provided with exits as specified in Part 18.

SECTION 906. *Light and Ventilation.* — Rooms used by human beings shall be provided with light and ventilation by means of windows or skylights with an area at least one eighth of the floor area or shall be provided with artificial light and a mechanically operated ventilating system providing not less than four complete changes of air per hour or fifteen cubic feet of air per minute for each occupant, whichever is greater.

SECTION 907. *Fire-Extinguishing Apparatus.* —

(a) Automatic sprinklers shall be installed in all

cellars and basements, of Divisions 2 and 3, of which the floor area is more than fifteen hundred square feet.

(b) Automatic sprinklers shall be installed throughout six-story buildings of Type III construction and buildings of Division 2 or 3, of Type IV construction, more than three stories in height or more than seventy-five hundred square feet in area.

(c) In buildings more than two stories high either portable fire-extinguishers not less than one for every thirty-five hundred square feet of floor area and at least one in each story, or first aid standpipes shall be provided.

(d) Fire department standpipes and first aid standpipes shall be provided in buildings more than seventy feet high.

## PART 10.

### SPECIAL REQUIREMENTS FOR GROUP H OCCUPANCY: DWELLINGS, LARGE.

#### SECTION

- 1001 — Group H Occupancy: Type, Height, Area.
- 1002 — Separation of Occupancies.
- 1003 — Exterior Walls.
- 1004 — Enclosure of Vertical Openings.
- 1005 — Exits.
- 1006 — Light and Ventilation.
- 1007 — Rooms.
- 1008 — Fire-Extinguishing Apparatus.
- 1009 — Plumbing and Heating.

SECTION 1001. *Group H Occupancy: Type, Height, Area.* — (a) Group H shall include such occupancies as —

*Division 1.* Hotels, apartment hotels, dormitories, lodging houses, convents, monasteries, and club

houses, with sleeping accommodations for ten or more persons, or for more than three families, or for more than two families above the first story, and without kitchens in the individual apartments.

*Division 2.* Apartment houses accommodating more than three families, or more than two families above the first story, and with kitchens in the individual apartments.

(b) Buildings or parts of buildings classified for occupancy in Group H and of the several types of construction shall not exceed in height and area of units of occupancy the following limits:—

TYPE OF CONSTRUCTION.	HEIGHT.		Maximum Area of Unit (Square Feet).
	Feet.	Stories.	
I . . . . . . . .	Not hereby limited		Not hereby limited
II . . . . . . . .	100	10	12,000
III . . . . . . . .	65	5	8,000
IV . . . . . . . .	65	5	6,000
VI . . . . . . . .	40	3	2,400

Type V construction shall not be used in buildings of Group H.

(c) Assembly halls in Group H buildings shall be classified in Group A or Group B as the case may be, and shall conform to the requirements of this code for the group in which they are so classified.

(d) The first floor of buildings more than two thousand square feet in area and more than three stories in height shall be of Type I or Type II construction. The basement ceilings of other buildings shall be of at least one-hour fire-resistive construction. All ceilings of buildings more than two thousand square feet in area and three stories or more in

height shall be of at least one-hour fire-resistive construction.

(e) Partitions forming separations between adjoining apartments shall be of not less than one-hour fire-resistive construction.

(f) Buildings of Type VI shall not be used for more than six families, nor more than four families above the first story.

SECTION 1002. *Separation of Occupancies.*—Group H occupancies shall be separated from other occupancies, and fire divisions of Group H occupancy shall be separated from adjoining fire divisions as specified in Part 13. A garage of not more than six cars capacity shall be separated from a Group H occupancy as specified in Part 12.

SECTION 1003. *Exterior Walls.*—(a) Exterior walls or parts of walls, except where fronting on a street, which are less than ten feet from a property line, shall be of at least two-hour fire-resistive construction and all openings in such walls which are less than seven feet six inches from a property line shall be protected by Class B fire doors or fire windows.

(b) Every portion of an exterior wall which faces, at a distance of less than fifteen feet, the further side of a street, or a combustible wall or roof, or an unprotected opening in a wall or roof of another building on the same lot, shall be of at least two-hour fire-resistive construction, and all openings in such portions shall be protected by Class B fire doors or fire windows.

(c) The commissioner may waive the requirements of this section, for protection of openings in walls, temporarily pending construction on an adjoining lot or across a street, provided the owner agrees in a writing recorded in the registry of deeds for Suffolk county to comply with the said requirements on demand of the commissioner.

SECTION 1004. *Enclosure of Vertical Openings.* —

(a) Elevator shafts, ventilating shafts and other vertical openings, except stairways and ramps, shall be enclosed.

(b) Stairways and ramps serving only the basement, first and second stories, excluding stairways serving as exits from sleeping rooms, need not be enclosed in the first and second stories. Such stairways and ramps except those which serve in the basement only lounges, restaurants and other rooms for the use of the public shall be enclosed in the basement. Other stairways and ramps which pierce only one floor shall be enclosed in the story above or below, but such stairways or ramps which serve as required exits from one story shall be enclosed in the other story. Other stairways and ramps shall be enclosed in all stories in which they occur, as specified in Part 15.

(c) In stairway enclosures not more than three stories high the doors in stories other than the basement or cellar need not be fire doors if they are of wood not less than one and one half inches thick.

(d) This section and Part 15 shall not be held to require enclosure of mezzanine floors in Group H buildings nor of vertical openings in such floors.

SECTION 1005. *Exits.* — (a) Every portion of a Group H building shall be provided with exits as specified in Part 18.

(b) Every apartment of less than four rooms shall have at least one exit opening upon a corridor which has at least two remote exits, or such apartment shall have two remote exits. Every apartment of four or more rooms shall have at least two remote exits. Such exits may open into a common corridor which has at least two remote exits.

(c) Every exit from an apartment shall be not more than fifty feet from the nearest exit from the story.

(d) Corridors which serve as common exits from two or more apartments shall have walls of at least one-hour fire-resistive construction. Such corridors and the exits therefrom shall be not less than thirty-six inches wide.

(e) Doors affording access from a stairway to a roof shall not be so locked as to prevent egress to the roof in emergency.

(f) Every stairway and corridor common to two or more apartments shall be adequately lighted at all times.

SECTION 1006. *Light and Ventilation.* — (a) Kitchens having a floor area more than seventy square feet and dining rooms, within apartments, all sleeping rooms and living rooms shall be provided with light and ventilation by means of windows in the exterior walls. The area of windows in each such room shall be not less than one eighth of the floor area thereof, nor less than eleven square feet, and such windows shall be arranged to open for

ventilation not less than one half the required area.

(b) The sills of required windows in kitchens shall be not more than fifty-six inches and in other rooms not more than thirty-six inches above the floor, and the tops shall be at least ninety inches above the floor.

(c) Every window required by paragraph (a) of this section shall front upon a street, alley or open passageway not less than fifteen feet wide, or upon a public park, cemetery, railroad right of way or other similar approved open space, or upon a yard or court of the dimensions herein specified. A court upon which such a window fronts shall be open to the sky and no cornice, balcony, stairway, fire escape or other construction shall encroach upon the required open area thereof herein specified. The height of a court shall be measured from the sill of the lowest window required to front upon it. The width and the horizontal area of such court shall not be less than as provided in the following numbered paragraphs (1) to (5), inclusive.

(1) If the court is open at both opposite ends for its full width and full height to a street, alley, park, or other permanently open space, not less than fifteen feet wide, or to a yard, it shall be a through court. The least width of such court shall be not less than six feet nor less than one tenth its length from open end to open end measured along the center line and not necessarily in a straight line. The width of such court at any level more than fifty feet above the sill of the lowest window required to front upon it shall be not less than six feet plus one eighth the excess of such height over fifty feet, except a court

the length of which is less than five times its least width. If windows required by this section face a wall on the opposite side of a through court in which windows also required by this section occur, the width of the court as determined by the foregoing requirements shall be increased by fifty per cent. The width of a through court need not, however, exceed the width required in this section for an inner court of the same height.

(2) If the court is open at one end for its full width and full height to a street, alley, park, or other permanently open space not less than fifteen feet wide, or to a yard, it shall be an outer court. The least width of such court shall be not less than eight feet nor less than one fourth its horizontal length measured along the center line, and not necessarily in a straight line. The width of such court at any level more than fifty feet above the sill of the lowest window required to front upon it shall be not less than eight feet plus one eighth the excess of such height over fifty feet, except a court the length of which is less than twice its least width. If windows required by this section face a wall on the opposite side of an outer court in which windows also required by this section occur, the width of the court as determined by the foregoing requirements in this paragraph shall be increased by fifty per cent. The width of an outer court need not, however, exceed the width required in this section for an inner court of the same height.

(3) Every court which is not open at one or both ends as provided for an outer court or a through court shall be an inner court. The least width of an inner court shall be not less than ten feet. The width

of such court at any level more than fifty feet above the sill of the lowest window required to front upon it shall be not less than ten feet plus one eighth the excess of such height over fifty feet. If windows required by this section face a wall on the opposite side of an inner court in which windows also required by this section occur, the width of the court as determined by the foregoing requirements in this paragraph shall be increased by fifty per cent. The horizontal area of an inner court shall be not less than three hundred square feet nor less above any floor level than sixty square feet for each story below said level served by such court. Every inner court shall be provided with an intake for fresh air, consisting of a court, corridor, passageway or ventilating duct, of which the area of cross-section below the level of the top of the lowest required window shall be not less than one fifteenth the maximum required area of the court. Such intake or the required area thereof shall be permanently open and unobstructed except for a grille or screen at least eighty per cent open at one or both ends and shall extend from the court to a street, alley, park, or other permanently open space, not less than fifteen feet wide, or to a yard, above the level of the ground thereof.

(4) Windows required by paragraph (a) of this section may front upon an open recess from the street, alley, park, court, yard or other open space from which they derive light and ventilation, provided the width of the recess is not less than four feet nor less than its horizontal depth, and its depth is not more than six feet. A recess from an inner court of width less than the required width of the court of which it is a part shall be disregarded in

computing, for the purpose of this section, the area of the court.

(5) The length of outer courts T-shaped in plan shall be measured from the open end to the end of each branch independently. A branch, open at only one end, of a through court, shall be considered to be a part of an outer court of length measured from the nearest open end to the closed end of the branch, in determining the width of such branch. Where a recess occurs at the closed end of an outer court the length of the court shall include the depth of the recess. Adjoining courts which conform independently to this section may be combined by omission of dividing walls. An inner court between two sections of a through court may be disregarded in computing the length of the through court. Other arrangements of courts shall be measured for the purposes of this section as determined by the commissioner with a view to providing for every required window light and ventilation substantially as herein specified.

(d) Every kitchen having a floor area not more than seventy square feet within an apartment and every room containing a water closet, shall be provided with light and ventilation by means of a window, except as specified in paragraph (e) of this section, in an exterior wall or in a ventilating shaft or, if such room is immediately under a roof, by a skylight in the roof. Such window or skylight shall have an area not less than three square feet nor less than one tenth of the floor area of the room, and shall be arranged to open for ventilation not less than three square feet nor less than one twentieth the floor area of the room. Such windows shall front

upon an open space or a ventilating shaft of which the width shall be not less than three feet and of which the horizontal area shall be not less than fifteen square feet. If the height of such space or shaft above the sill of the lowest window served is in excess of fifty feet, the width thereof shall be increased one half foot and the area eight square feet for every ten feet or fraction of such excess. If such ventilating shaft is covered, the covering shall be a skylight with openings under the edges thereof on at least three sides equal in the aggregate to at least twice the required area of the ventilating shaft.

(e) Rooms containing water closets need not have windows as specified in paragraph (d) of this section if they are provided with adequate artificial light and an approved system of mechanical ventilation which will completely exhaust the air in the room at least four times per hour. A kitchen having a floor area not more than seventy square feet within an apartment need not have windows if it is so provided with artificial light, and such mechanical ventilation or ventilation by means of a ventilating exhaust duct with at least one square foot net area of cross-section independent of ducts from other rooms to a point above the roof. A kitchen ventilated as provided in this paragraph or by a ventilating shaft shall have a permanent opening of adequate size for fresh air which may, however, be drawn from other rooms in the apartment.

(f) Dining rooms in hotels, dining rooms common to more than one family, kitchens serving such dining rooms and other kitchens and rooms for eating purposes except those within apartments, shall be provided with light and ventilation as specified for

kitchens and dining rooms respectively in paragraphs (a), (b) and (c) of this section or shall have artificial light and an approved system of mechanical ventilation providing not less than four complete changes of air per hour.

(g) The boundary line of a lot on which a building is to be erected subject to the provisions of this section, unless it is a common boundary between such lot and a street, alley, public park, cemetery, railroad right of way or other similar, permanently open space, not less than fifteen feet wide shall be a boundary to an adjacent court or ventilating shaft required by this section as though a wall without windows were erected on such line. If there is, appurtenant to such lot, an easement for light and air over a portion of an adjoining lot, in terms which assure that the easement will remain in force and effect so long as any windows require it for light and ventilation under the provisions of this code, and duly recorded in the registry of deeds for Suffolk county, the portion subject to such easement may be considered to be part of such lot for the purposes of this section. No building or structure shall be erected in such manner as to reduce the light and ventilation in a building on the same lot subject to the provisions of this section below the requirements thereof, nor shall a lot line be moved by sale of land or otherwise so as to permit such reduction by a building on an adjoining lot.

(h) In a residence district, as defined in chapter four hundred and eighty-eight, of the acts of nineteen hundred and twenty-four, a building of Division 2 upon a lot which abuts on only one street shall have a yard at the rear. Such yard shall be open and

unobstructed above the level of the sills of windows opening thereon required by this section, shall extend the full width of the lot, and shall have a depth, measured from the rear of the building to the rear line of the lot or, if an alley or open passageway lies at the rear of the lot, to the middle line of such alley or passageway, not less than twelve feet nor less than one fourth the height of the building above the sill of the lowest window required to front upon such yard. If the rear line of such lot is other than a straight line the required yard shall have an area not less than twelve feet times the width of the lot at the rear of the building and the building shall be so disposed at the rear as to leave a yard having approved continuity with the yards of adjoining lots. The provisions of this paragraph shall not apply to a lot which abuts at the rear upon a railroad right of way, cemetery, park or other permanently open space, not less than fifteen feet wide. The Boston zoning law (chapter four hundred and eighty-eight of the acts of nineteen hundred and twenty-four) also contains provisions relative to yards.

(i) Every room containing a water closet in an apartment shall have adequate means for lighting at night.

SECTION 1007. *Rooms.*—(a) In every apartment of an apartment house or apartment hotel, at least one room shall have a floor area not less than one hundred and twenty square feet. Every kitchen in such apartment shall be not less than six feet wide nor less than forty-eight square feet in area. Every room containing a water closet shall be not less than thirty-three inches wide and shall have a floor area

not less than fifteen square feet. Every other room in such apartment, except closets and vestibules, shall have not less than seventy square feet of floor area.

(b) Rooms in apartments, except closets, shall be at least eight feet high in half their required area, an average of at least six feet high in the remainder of the required area, and not less than four feet high at any point within the required area.

(c) If the walls or floor of a sleeping room or living room are in contact with the ground, the portions thereof in such contact shall be waterproofed as specified in Part 29 or damp proofed in an approved manner, and the interior finish of such portions of the walls of such rooms shall be furred with impervious material. Not more than thirty per cent of the area of the walls enclosing such a room shall be in contact with the ground.

(d) The floor of every room containing a water closet shall be of tile, terrazzo, linoleum or other impervious material with a base of similar material around the walls at least four inches high. No water closet shall be enclosed in woodwork placed close about the fixture. The walls of every room containing a water closet shall extend to the ceiling.

#### SECTION 1008. *Fire-Extinguishing Apparatus.* —

(a) Automatic sprinklers shall be installed in cellars, basements, workrooms, shops, store rooms and kitchens other than in apartments, in buildings of Type I and Type II construction more than six stories high and in other buildings more than three stories high, and in all kitchens and shafts in buildings of Types III and IV more than three stories high.

(b) First aid standpipes, as specified in Part 30, or portable extinguishers, at least one for every twenty-five hundred square feet of floor area and at least one in each story, shall be provided in buildings more than five thousand square feet in area or more than six stories high and in Type III or Type IV buildings more than three stories high.

(c) Fire department standpipes and first aid standpipes shall be installed in buildings more than seventy feet high.

SECTION 1009. *Plumbing and Heating.* — (a) Every apartment in an apartment house and every apartment of two or more rooms in an apartment hotel shall have within it at least one room containing a water closet and devoted exclusively to use as a bathroom or toilet room. One such room shall be accessible from every sleeping room without passing through another sleeping room. In every such apartment there shall be a lavatory or sink with running water.

(b) Every apartment in a hotel and every apartment in an apartment hotel not included in paragraph (a) of this section shall have within it at least one room containing a water closet, as specified in paragraph (a) of this section, or shall have access in common with other apartments to such a room in the same story or in the next story above or below, by means of a common corridor. Where the number of sleeping rooms without a water closet within the apartment exceeds six in a story, separate toilet rooms for men and for women shall be provided in the same story, plainly marked, and shall contain one water closet for every nine sleeping

rooms or fraction of nine. Common bathrooms shall have means for securely locking the door on the inside. Every such room shall contain at least one lavatory or sink with running water.

(c) In every apartment of an apartment house or apartment hotel which is not adequately heated from a central heating plant, at least one room with a floor area not less than one hundred and twenty square feet shall have a chimney, as specified in Part 21, with a separate flue not less than eight inches in diameter, or a common flue not less than twelve inches in diameter, with a thimble at least six inches in diameter about six feet above the floor.

(d) In buildings more than three stories high, every boiler room or room containing a central heating plant shall be separated from the rest of the building by at least a two-hour separation as specified in Part 13.

## PART 11.

### SPECIAL REQUIREMENTS FOR GROUP I OCCUPANCY: DWELLINGS, SMALL.

#### SECTION

- 1101 — Group I Occupancy: Type, Height, Area.
- 1102 — Separation of Occupancies.
- 1103 — Exterior Walls.
- 1104 — Enclosure of Vertical Openings.
- 1105 — Exits.
- 1106 — Light and Ventilation.
- 1107 — Fire-Extinguishing Apparatus.

SECTION 1101. *Group I Occupancy: Type, Height, Area.* — (a) Group I shall include such occupancies as —

*Division 1.* Dwellings accommodating not more than three families, nor more than two families above the first story.

*Division 2.* Dormitories, lodging houses, clubs, convents and monasteries, with sleeping accommodations for less than ten persons.

(b) Buildings or parts of buildings classified for occupancy in Group I shall be limited as to type of construction, height and area of units, as follows:—

TYPE OF CONSTRUCTION.	HEIGHT.		Maximum Area of Unit (Square Feet).
	Feet.	Stories.	
I . . . . . . . .	Not hereby limited		Not hereby limited
II . . . . . . . .	100	10	12,000
III . . . . . . . .	65	5	8,000
IV . . . . . . . .	65	5	6,000
V . . . . . . . .	40	3	5,000
VI . . . . . . . .	40	3	5,000

(c) The basement or cellar ceiling of all Group I buildings, more than three stories in height, shall be of not less than one-hour fire-resistive construction.

SECTION 1102. *Separation of Occupancies.*— Group I occupancies shall be separated from other occupancies, and fire divisions of Group I occupancy shall be separated from adjoining fire divisions as specified in Part 13. A garage of not more than six cars capacity may be constructed as part of a Group I building as specified in Part 12.

SECTION 1103. *Exterior Walls.*— (a) Exterior walls or parts of walls, except where fronting on a street, which are less than five feet from a property line shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows.

(b) In buildings of Type V construction, exterior walls of unprotected metal may be considered to meet the requirements of this section for two-hour walls.

SECTION 1104. *Enclosure of Vertical Openings.* —

(a) Elevator shafts, ventilating shafts and other vertical openings, except stairways, shall be enclosed.

(b) Where two or more stairways are required as exits at least one shall be enclosed in all stories in which it occurs. Stairways which pierce more than three floors shall be enclosed.

(c) In stairway enclosures not more than three stories high, the doors in stories other than the basement or cellar need not be fire doors if they are of wood not less than one and one half inches thick.

(d) This section shall not apply to buildings of Division 1, referred to in section 1101.

SECTION 1105. *Exits.* — Group I buildings more than three stories in height, and Group I buildings in which the area of any floor, except the first floor, exceeds fifteen hundred square feet, shall have at least two stairways or ramps, one of which shall be interior and enclosed.

SECTION 1106. *Light and Ventilation.* — (a) Rooms of Group I buildings used for eating, living or sleeping purposes, shall be provided with light and ventilation by means of windows the area of which shall be not less than one eighth of the total floor area of such room or rooms. The space on which such windows shall open shall not be less than as specified in Part 10 for similar windows in Group H buildings.

(b) Kitchens and rooms containing water closets shall be lighted and ventilated as provided for similar rooms of Group H buildings in Part 10.

SECTION 1107. *Fire-Extinguishing Apparatus.* —

(a) Automatic sprinklers shall be installed in cellars, basements, workrooms, shops, storerooms and kitchens other than in apartments, in buildings more than six stories high and in Type III and Type IV buildings more than three stories high.

(b) First aid standpipes, as specified in Part 30, or portable fire-extinguishers, at least one for every twenty-five hundred square feet of floor area and at least one in each story shall be provided in Group I buildings more than five thousand square feet in area or more than six stories high and in Type III or Type IV buildings more than three stories high.

(c) Fire department standpipes and first aid standpipes shall be installed in buildings more than seventy feet high.

(d) This section shall not apply to buildings of Division 1, referred to in section eleven hundred and one.

PART 12.

SPECIAL REQUIREMENTS FOR GROUP J OCCUPANCY:  
MISCELLANEOUS STRUCTURES.

SECTION

1201 — Group J Occupancies: Type, Height, Area

1202 — Separation of Occupancies.

1203 — Exterior Walls.

1204 — Exits.

1205 — Aisles and Seating.

1206 — Light and Ventilation.

1207 — Fire-Extinguishing Apparatus.

1208 — Floor Finish.

SECTION 1201. *Group J Occupancies: Type, Height, Area.* — (a) Group J shall include such occupancies as —

*Division 1.* Garages for six cars or less.

*Division 2.* Tanks, towers, advertising signs and similar structures.

*Division 3.* Amusement park structures, reviewing stands, grand stands, and similar structures.

(b) Garages for six cars or less, not exceeding two stories in height nor thirteen hundred square feet in floor area, may be of any type of construction except Type VI. Garages, for three cars or less, one story in height and not exceeding six hundred and fifty square feet in area, may be of Type VI construction. Garages for six cars or less may be built of Type VI construction subject to the provisions of Part 7.

(c) Structures of Division 2, erected on the roof or on the facade of a building in the first or second fire zone shall be constructed of incombustible materials except water tanks, flag poles, signs not more than thirty inches in least width flat against the exterior wall and signs not more than fifteen square feet in area.

(d) Reviewing stands and grand stands may be constructed of masonry, reinforced concrete, steel or wood or any combination thereof. When constructed, except for the seats, of incombustible materials, the size shall not hereby be limited. When the structure below the deck is constructed of incombustible material, and the decking is of wood or other combustible material, the horizontal distance from front to back shall not exceed one hundred feet. When the entire structure is constructed of wood or

other combustible material, the horizontal distance from front to back shall not exceed fifty feet.

(e) Amusement park structures of the open or skeleton framed type may be constructed of any type of construction and are not hereby limited in height and area.

(f) Amusement park structures of the enclosed type, shall be limited as to type of construction, height and area of units, as follows: —

TYPE OF CONSTRUCTION.	HEIGHT.		Area of Unit (Square Feet).
	Feet.	Stories.	
I . . . . . . . .	Not hereby limited		Not hereby limited
II . . . . . . . .	75	4	15,000
III . . . . . . . .	55	3	10,000
IV . . . . . . . .	35	2	10,000
V . . . . . . . .	35	2	5,000
VI . . . . . . . .	35	2	5,000

(g) Amusement park structures of enclosed type used as places of assembly shall be classified in Group A or Group B in accordance with the definitions thereof.

(h) The maximum areas provided in this section may be increased fifty per cent if the entire floor area is protected by automatic sprinklers.

SECTION 1202. *Separation of Occupancies.* — (a) When a garage of size and arrangement to accommodate not more than two cars is constructed as part of a Group H or Group I building, the walls and ceilings of the garage shall be of not less than one-hour fire-resistive construction. When a garage to accommodate more than two but not more than six

cars is constructed as part of a Group H or Group I building, the walls and ceiling of the garage shall be of not less than three-hour fire-resistive construction. Openings in such walls shall be protected by Class B fire doors or by fire windows. A garage to accommodate not more than six cars shall be separated from other occupancies and from adjoining fire divisions as specified in Part 13.

(b) In a separation between a garage of Group J occupancy and another occupancy there shall not be more than one opening, and the sill thereof shall be raised one foot above the garage floor. There shall be no opening from a garage directly into a living room, sleeping room or kitchen.

SECTION 1203. *Exterior Walls.* — Exterior walls or parts of walls, of Group J structures, except where fronting on a street, which are less than five feet from a property line or less than ten feet from another building on the same lot, shall be of not less than one-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows, and such walls which are less than three feet from a property line or less than six feet from another building on the same lot, shall be of at least two-hour fire-resistive construction and all openings therein shall be protected by Class B fire doors or fire windows, except that in garages for three cars or less of Type V construction, such walls may be of unprotected metal.

SECTION 1204. *Exits.* — (a) Reviewing stands, grand stands and similar structures shall be provided with exits not less than four feet wide nor less than

one foot in width for each three hundred persons or fraction thereof served. Exits shall have not less than seven feet in clear height nor be more than sixty feet apart.

(b) Where the space under a grand stand, reviewing stand or similar structure is used for any purpose other than ingress and egress, the required exits through this space shall be enclosed by walls, floors, and ceilings of not less than one-hour fire-resistive construction.

(c) Amusement park structures, other than grand stands or similar structures, of either open or enclosed type shall be provided with exits as required for Group B occupancy in Part 4.

**SECTION 1205. *Aisles and Seating.*** — Reviewing stands, grand stands and similar structures having more than twenty rows of seats shall have transverse aisles not over sixty feet apart leading to exits. Transverse aisles shall have a clear width not less than thirty inches nor less than one foot for every three hundred persons or fraction thereof served. Where separate seats are not provided or marked off, a width of eighteen inches shall be considered one seat in computing the required width of aisles and exits.

**SECTION 1206. *Light and Ventilation.*** — Amusement park structures shall be provided with light and ventilation sufficient to avoid dangerous or unhealthful conditions as may be required by the commissioner. If used after dark, they shall be lighted by artificial light sufficiently for safe egress.

**SECTION 1207. *Fire-Extinguishing Apparatus.*** — Fire-extinguishing apparatus shall be provided in

Buildings and structures of Group J where the fire hazard, in the judgment of the commissioner, is commensurate with that for which such apparatus is specified in buildings of other groups.

SECTION 1208. *Floor Finish.*—Garages shall have non-absorbent incombustible floor finish.

## PART 13.

### SEPARATION OF OCCUPANCIES.

#### SECTION

- 1301 — Multiple Occupancies.
- 1302 — Separations.

SECTION 1301. *Multiple Occupancies.*—(a) A fire division, whether occupying the whole or a part of a building, shall be limited as to type of construction, height and area as provided in Parts 3 to 12, inclusive, according to its principal occupancy.

(b) Adjoining fire divisions in a building shall be separated by a separation at least as fire-resistive as specified in Schedule B; Required Separations between Fire Divisions, in section thirteen hundred and two.

(c) A fire division may contain two or more units of different occupancies, and every such unit shall be limited as to height above the ground and as to area as provided in Parts 3 to 12, inclusive, according to its occupancy and the type of construction of the building.

(d) Adjoining units of different occupancy in a fire division shall be separated by a separation at least as fire-resistive as specified in Schedule A; Required Separations between Different Occupancies

in One Fire Division. Space within a unit of occupancy used for a purpose or process customarily incidental to that occupancy and under the same management and control shall not be considered a separate unit of occupancy unless the floor area of such space exceeds one tenth the area of the fire division in which it is located; but garage use shall not so be considered incidental.

(e) Every unit of occupancy shall conform to the provisions of Parts 3 to 12 of this code for the group and division in which it is classified.

(f) Two adjoining fire divisions may be of different types of construction subject to the following limitations:—

(1) Construction required to be of Type I shall not be supported wholly or in part by construction of any other type.

(2) Construction required to be of Type II shall not be supported by construction other than Type I or Type II.

(3) Construction required to be of Type III shall not be supported by construction other than of Type I, Type II or Type III.

(4) Construction required to be of Type IV shall not be supported by construction of Type V or Type VI.

(5) Construction required to be of Type V shall not be supported by construction other than of Type I, Type II or Type V.

(g) Separations, as specified in this code, may be vertical, horizontal, or inclined, depending upon the relative position of the portions of the building to be separated, and shall consist of a system of walls, partitions, floors or other construction of such ma-

terials and construction and so arranged as to provide a complete, secure and continuous fire-break of the required fire-resistive rating between the portions of the building separated.

SECTION 1302. *Separations.* — (a) Separations between units of occupancy within a fire division and between fire divisions of a building shall be classified, each classification being designated in Schedule A and Schedule B of this section by the letter or figure set against it, as follows:—

- A — Absolute Separation.
- 4 — Four-hour separation.
- 3 — Three-hour separation.
- 2 — Two-hour separation.
- 1 — One-hour separation.
- N — No separation required.

(b) An absolute separation shall provide in all its parts effective fire-resistance of not less than four-hour rating as specified in Part 22 and shall have no openings.

(c) A four-hour separation shall provide effective fire-resistance of not less than four-hour rating as specified in Part 22. Openings in the walls of such separations shall be protected on each side thereof by automatic-closing Class A fire doors as specified in Part 22. The sum of the areas of such openings in one story shall not exceed one third the area of the wall and no single opening shall have a greater area than one hundred square feet.

(d) A three-hour separation shall provide effective fire-resistance of not less than three-hour rating as specified in Part 22. Openings in the walls of such separations shall be protected on each side thereof

by automatic-closing Class B fire doors as specified in Part 22. The sum of the areas of such openings in one story shall not exceed one third the area of the wall and no single opening shall have a greater area than two hundred square feet.

(e) A two-hour separation shall provide effective fire-resistance of not less than two-hour rating as specified in Part 22. Openings in the walls of such separations shall be protected on one side thereof by automatic-closing Class A fire doors as specified in Part 22. The sum of the areas of such openings in one story shall not exceed one third the area of the wall and no single opening shall have a greater area than two hundred square feet.

(f) A one-hour separation shall provide effective fire-resistance of not less than one-hour rating as specified in Part 22. Openings in the walls of such separations shall be protected on one side thereof by automatic-closing Class B fire doors as specified in Part 22.

(g) Walls which form separations between fire divisions shall be fire walls as specified in Part 14. Such walls, whether bearing or non-bearing, shall be solid masonry not less than eight inches thick or reinforced concrete not less than six inches thick. Openings in fire walls shall have fire doors on both sides.

(h) The commissioner may waive in part the requirements of this section for the protection of openings less than two square feet in area subject to such conditions as he shall in each case specify.

(i) A fixed fire window, as specified in Part 22 may be considered equivalent to one Class B fire door in the walls of separations, but two such win-

SCHEDULE A. — REQUIRED SEPARATIONS BETWEEN DIFFERENT OCCUPANCIES IN ONE FIRE DIVISION.

(Above Zigzag Line.)

SCHEDULE B. — REQUIRED SEPARATIONS BETWEEN FIRE DIVISIONS

(Below Zigzag Line)

dows shall not be substituted as equivalent to two doors in an opening where two fire doors are required.

The separations of Schedule B between adjoining fire divisions of Type I, Type II, and Type V construction shall be as listed. If either of such fire divisions is of Type III, Type IV, or Type VI construction, an absolute separation shall be provided for Schedule B where a four-hour separation is listed.

and all other separations in the table shall be increased one hour.

Separations between units of Group J, Division 1 occupancy and units in the same fire division of Group H or Group I occupancy are specified in Part 12.

## PART 14.

### WALLS AND PARTITIONS.

#### SECTION

- 1401 — Classification of Walls for Use or Function.
- 1402 — General Requirements for Walls.
- 1403 — Lateral Support of Walls.
- 1404 — Classification of Walls for Type of Construction.
- 1405 — Reinforced Concrete Walls.
- 1406 — Masonry Walls.
- 1407 — Bond in Masonry.
- 1408 — Lateral Support of Masonry.
- 1409 — Masonry Piers.
- 1410 — Beam Supports on Masonry Walls.
- 1411 — Masonry Chases, Recesses, Corbels and Lintels.
- 1412 — Masonry Foundation Walls.
- 1413 — Parapet Walls.
- 1414 — Use of Existing Masonry Walls.
- 1415 — Masonry Veneer.
- 1416 — Steel Frame Walls.
- 1417 — Wooden Frame Walls.

SECTION 1401. *Classification of Walls for Use or Function.* — (a) Walls and partitions shall be classified for use or function in classifications which are mutually exclusive only to the extent indicated in their definitions.

- (1) A bearing wall is a wall which supports a floor, roof or other vertical load in addition to its own weight.
- (2) A non-bearing wall is a wall which supports no vertical load other than its own weight.
- (3) An exterior wall is a wall separating the in-

terior from the exterior of a building, marking the boundary or extent thereof which may be and usually is exposed to the weather on one side.

(4) An interior wall is a wall wholly within a building and protected from the weather.

(5) A party wall is a wall used or adapted for use in common as a part of two buildings. A party wall may be either bearing or non-bearing. A party wall marks the boundary or extent of each building of which it is a part.

(6) A fire wall is an interior wall, bearing or non-bearing, forming part of a separation between two fire divisions of a building, as provided in Part 13.

(7) A partition is an interior wall, bearing or non-bearing, not over one story in height, the chief function of which is to separate two rooms of a story. A partition in one story may be supported by a bearing partition in the story below.

(8) A foundation wall is a foundation in the form of a wall, either exterior or interior; that portion of the exterior bearing wall of a building which is below the grade of adjoining ground.

(9) A retaining wall is a wall of which the chief function is to resist the lateral displacement of liquid, granular or other materials. It may be either bearing or non-bearing, exterior or interior.

(10) A curtain wall is an exterior, non-bearing wall more than one story high and not supported at each floor level, which is laterally stayed either by masonry piers or by the structural frame of the building.

(11) A panel wall is an exterior, non-bearing wall not over one story high, or supported at each floor level.

(12) An enclosure wall is an interior wall, bearing or non-bearing, which encloses a stairway, elevator shaft or other vertical opening.

**SECTION 1402. *General Requirements for Walls.* —**

(a) Walls shall have the resistance to fire and to the spread of fire required of them in Parts 3 to 13, inclusive, and Part 15 of this code, but may be finished, except on the outside of exterior walls and within enclosures of vertical openings, with wooden or other combustible wainscoating, insulating or acoustical material. In Type III buildings, there shall be no concealed air spaces between such finish and the wall. In Type V buildings such material shall be protected from fire on both sides by sheet metal or its equivalent. In Type IV or Type VI buildings every hollow space in walls shall be fire-stopped at floor and ceiling.

(b) Bearing walls shall be so supported and constructed as to be stable and to support their weight and the loads which may be placed upon them without exceeding the stresses allowed for the materials of which they are constructed as provided in Parts 23 to 29, inclusive. Exterior walls, party walls, bearing walls and fire walls and their vertical or lateral supports shall be capable of resisting the pressure of the wind applied to either side.

(c) Court walls shall be of such fire-resistive construction and shall have such limitations as to openings and the protection of openings as are specified for exterior walls in Parts 3 to 12, inclusive.

(d) Exterior bearing walls of buildings of Type I, Type II, Type III and Type IV shall be of four-hour fire-resistive construction as provided in sections

one hundred and twenty-six to one hundred and twenty-nine, inclusive, of Part 1, whether such walls consist of reinforced concrete or masonry bearing walls, of masonry piers, or of reinforced concrete or protected structural skeleton construction. Where such exterior walls are required, in Parts 3 to 12, inclusive, to be without openings the panels or non-bearing portions of the walls shall afford resistance of four-hour rating to the spread of fire. Where openings in such exterior walls are required, in Parts 3 to 12, inclusive, to be protected with fire doors or fire windows, the panels or non-bearing portions of the walls shall afford resistance of two-hour rating to the spread of fire. Where the openings in such exterior walls are unrestricted, the panels or non-bearing portions of such walls shall be of incombustible construction except for the sashes and frames of windows, blinds, shutters, screens, awnings, doors and door frames which may be of wood. Combustible material other than canvas awnings shall not be applied or attached to the outside of exterior walls of such buildings. Panel wall construction about the glass of display windows fronting on a public way and not more than two stories high above the ground may be of wood or other combustible material covered with metal or equivalent protection on the outside.

(e) In buildings with combustible floors, doorways required to have fire doors shall have incombustible thresholds the full thickness of the wall and, where a door is hung, extending at least four inches from the face of the wall and laterally at least six inches beyond each jamb of the doorway. Thresholds may be flush with the floor.

SECTION 1403. *Lateral Support of Walls.* — (a) Walls of any type or construction may be considered to have lateral support where anchored or secured:—

- (1) To intersecting walls of equal or better fire-resistance.
- (2) To buttresses or piers.
- (3) To the floors, roof and framing.

SECTION 1404. *Classification of Walls for Type of Construction.* — (a) Walls, including partitions, shall be classified for type of construction as follows:—

- (1) Reinforced concrete.
- (2) Masonry.
- (3) Steel frame.
- (4) Wooden frame.

(b) Any wall which does not fall readily into one of the classifications of this section shall be assigned thereto by the commissioner according to its pertinent characteristics.

SECTION 1405. *Reinforced Concrete Walls.* — (a) Reinforced concrete walls may be used for any use or function described in section fourteen hundred and one.

(b) Reinforced concrete walls other than foundation walls shall be supported upon foundations of concrete or masonry or upon construction of masonry, reinforced concrete or structural steel the metal of which, except as otherwise provided in section fourteen hundred and eleven, shall have protection against fire of at least the rating required for the wall itself, and not less than two-hour fire-resistive protection. Reinforced concrete walls shall

not be supported upon wood except wooden piles or other approved under-water construction of wood.

(c) The pertinent provisions of Part 26 shall apply to walls of reinforced concrete.

(d) Reinforced concrete bearing walls shall have a thickness of at least one twenty-fifth the height or length between supports, whichever is the lesser dimension.

(e) Foundation walls of reinforced concrete shall be not less than eight inches thick.

(f) Non-bearing walls of reinforced concrete, shall have a thickness of at least one sixtieth of the height or length between lateral supports, whichever is the lesser dimension, and shall not be thinner than three inches. Reinforced concrete beams which serve in part as walls shall conform to the requirements for non-bearing walls.

(g) Party and fire walls of reinforced concrete shall be at least six inches thick.

(h) Walls of reinforced concrete may be covered with a veneer of masonry or other material adequately supported but such veneer shall not be considered to be a part of the wall for the purposes of this section.

(i) No chase or recess shall be cut or formed in a reinforced concrete wall so as to impair its stability, or to reduce the minimum thickness to less than four inches.

(j) Where structural steel beams or other metal members frame into exterior, party, fire or enclosure walls of reinforced concrete, the ends shall have protection against fire of the rating specified for the wall. Where wooden joists, beams or other combustible members frame into such walls, the ends

shall be separated from the opposite side of the wall and from such members framing into the opposite side of the wall by not less than four inches of concrete. In buildings of Type III, Type IV or Type VI construction party walls and fire walls shall extend through the roof as provided in section fourteen hundred and thirteen.

(k) Exterior and bearing walls of reinforced concrete shall be anchored to the floor and roof construction as specified in Parts 16 and 17.

SECTION 1406. *Masonry Walls.*—(a) Masonry may be used for walls of any use or function described in section fourteen hundred and one. Specifications for masonry in this chapter shall also apply to plain concrete.

(b) Masonry walls and piers, other than foundation walls, shall be supported upon foundations of concrete or masonry, or upon construction of masonry, reinforced concrete or structural steel the metal of which, except as otherwise provided in section fourteen hundred and eleven, shall have protection against fire of at least the rating required for the wall itself, and not less than two-hour fire-resistive protection. Masonry walls and piers shall not be supported upon wood except wooden piles or other approved under-water construction of wood, but this provision shall not apply to fire stopping and nogging.

(c) Exterior bearing walls of masonry shall have a thickness of at least one sixteenth the height or length between lateral supports in the top story of a building and at least one twentieth such height or length in stories other than the top, whichever is the lesser dimension. No masonry bearing wall in any

story shall be thinner than the wall which it supports in the story next above. Masonry exterior bearing walls supporting the walls of Type V or Type VI buildings shall be not less than eight inches thick.

(d) Exterior bearing walls of masonry, except in buildings of Groups D, H, and I occupancy, and exterior bearing walls of hollow masonry, or of hollow masonry units in buildings of Groups D, H, and I occupancy, shall have at least the thickness given in the following table:

*Minimum Thickness (Inches) of Masonry Exterior Bearing Walls.*

STORY.	HEIGHT OF WALL IN STORIES.							
	8.	7.	6.	5.	4.	3.	2.	1.
Eighth . . . . .	12	-	-	-	-	-	-	-
Seventh . . . . .	12	12	-	-	-	-	-	-
Sixth . . . . .	12	12	12	-	-	-	-	-
Fifth . . . . .	16	12	12	12	-	-	-	-
Fourth . . . . .	16	16	12	12	12	-	-	-
Third . . . . .	16	16	16	12	12	12	-	-
Second . . . . .	20	16	16	16	12	12	12	-
First . . . . .	20	20	16	16	16	12	12	12
Basement . . . . .	20	20	20	16	16	16	12	12

In a building not over one story or twelve feet high nor more than one thousand square feet in area the masonry exterior bearing walls in the first story need not exceed eight inches in thickness. In buildings of other than Groups D, H, and I occupancy, hollow masonry or masonry of hollow units shall not be used in exterior bearing walls below the topmost three stories.

(e) In buildings of Group D, Group H and Group I occupancy, except as provided in paragraph (f),

exterior bearing walls of solid masonry shall have at least the thickness given in the following table:—

*Minimum Thickness (Inches) of Solid Masonry Exterior Bearing Walls, Buildings of Groups D, H and I.*

STORY.	HEIGHT OF WALL IN STORIES.							
	8.	7.	6.	5.	4.	3.	2.	1.
Eighth . . . . .	12	-	-	-	-	-	-	-
Seventh . . . . .	12	12	-	-	-	-	-	-
Sixth . . . . .	12	12	12	-	-	-	-	-
Fifth . . . . .	12	12	12	12	-	-	-	-
Fourth . . . . .	12	12	12	12	12	-	-	-
Third . . . . .	16	12	12	12	12	12	-	-
Second . . . . .	16	16	12	12	12	12	8	-
First . . . . .	16	16	16	12	12	12	12	8
Basement . . . . .	16	16	16	16	12	12	12	12

(f) In buildings of Group I which are single-family dwellings not over three stories high, exterior bearing walls of masonry supporting floors not over twenty feet in span shall have at least the thickness given in the following table:—

*Minimum Thickness (Inches) of Masonry Bearing Walls, Single Family Dwellings.*

STORY.	HEIGHT OF WALL IN STORIES.		
	3.	2.	1.
Third . . . . .	8	-	-
Second . . . . .	8	8	-
First . . . . .	12	8	8
Basement . . . . .	12	12	8

(g) Interior bearing partitions of masonry, supporting not more than one floor and a roof shall have a thickness of at least one twentieth the height or

length between lateral supports, whichever is the lesser dimension, and at least six inches. Such partitions, not over one story high, supporting stairs, stair landings, platforms, a mezzanine floor, or the like, shall have a thickness of at least one twentieth the height or length between lateral supports, whichever is the lesser dimension, and at least three and one half inches. Other interior bearing walls of masonry shall have at least the thickness required in this section for masonry exterior bearing walls.

(h) Bearing party walls of masonry shall be solid not less than twelve inches thick. Non-bearing party walls and bearing or non-bearing fire walls of masonry shall be solid not less than eight inches thick.

(i) Exterior masonry panel walls shall be not less than three and one half inches thick. Panel walls more than four feet high, and curtain walls, of masonry shall be not less than eight inches thick. Panel or curtain walls of metal or other material may be backed up with masonry of less thickness.

(j) Non-bearing masonry partitions and enclosure walls shall have a thickness of at least one forty-fifth the height or length between lateral supports, whichever is the lesser, and at least three inches.

(k) The minimum thickness specified in this section for masonry walls, except as otherwise provided in this paragraph, shall be exclusive of unbonded veneer, plaster or other covering on either face of the wall. The minimum thickness specified in this section for non-bearing partitions and enclosure walls shall be inclusive of plaster which is at least one half inch thick on either or both sides, and when the masonry beneath the plaster is at least three inches thick.

SECTION 1407. *Bond in Masonry.*—(a) Brick walls shall be bonded with at least one full header, every other brick in every sixth course, both on the face and in the interior of the walls.

(b) Running bond may be used on the face of a brick wall provided the face is bonded to the backing at every sixth course by split brick in the face course and a continuous course of bonding headers (stretchers in an eight-inch wall) in the backing, overlapping the face course not less than one and one half inches.

(c) In homogeneous walls of stone masonry, bond stones shall be uniformly distributed and shall have a cross-section not less than ten per cent of the area of the wall.

(d) In homogeneous masonry walls of structural clay tile or of solid or hollow concrete or gypsum blocks or of similar masonry units, unless all the units are the full thickness of the wall, the two faces of the wall shall be bonded together through the wall, by varying the thickness of units in alternate courses so that the blocks will overlap across the wall not less than three and one half inches.

(e) Walls of structural clay tile, concrete blocks or similar masonry units, faced with brick, in which the backing is bonded as required for the material of which it is built and the brick facing is bonded to the backing as required in a brick wall, shall be considered to have the strength and stability of a homogeneous wall of the same total thickness of the weaker material.

(f) A wall of stone, brick, structural clay tile, concrete blocks or other masonry units faced with stone ashlar bonded to the wall as herein provided, shall

be considered to have the strength and stability of a homogeneous wall of the same total thickness of the weaker material. In order so to be considered a part of the wall, the ashlar facing shall be laid in a full bed of mortar, shall be not less than three and one half inches thick and bond stones shall be uniformly distributed in all or at least in alternate courses, not less than seven and one half inches thick, nor less than four inches thicker than the remainder of the facing, and constituting not less than twenty per cent of the area of the wall.

(g) Brick, stone or block facing may be considered to be bonded to backing of plain or reinforced concrete when the facing, with all the provisions for bond required for a facing backed with masonry, is laid in advance of the pouring of concrete, and the concrete is poured in direct contact with the facing, embedding the header brick or bonding units.

(h) Masonry walls covered with a veneer not bonded to the wall as provided for a facing in this section shall be considered to have a thickness equal to that of the wall exclusive of the veneer.

(i) Hollow walls of brick, laid with every alternate brick in every other course on each side of the wall a full header, or any equivalent bond, may be used where walls of structural clay tile may be used.

SECTION 1408. *Lateral Support of Masonry.* —

(a) Masonry bearing walls, exterior walls, and other masonry walls, which depend upon intersecting walls for lateral support shall be well bonded to such walls at intersections and corners.

(b) Masonry walls which depend upon anchorage

to the frame of a building for lateral support shall be tied to the frame by suitable anchorage.

(c) Exterior and bearing walls of masonry shall be anchored to the floor and roof construction as specified in Part 16.

SECTION 1409. *Masonry Piers.*—(a) In walls with openings such that the portion of wall between openings constitutes a pier, such portion of wall shall be computed and constructed as required for piers. The height of such a pier, with a continuous wall above and below the openings shall be taken as the height of the openings.

(b) When the clear horizontal distance between piers in masonry walls exceeds ten feet they shall be considered isolated piers.

(c) Isolated piers shall be built of solid units, for which hollow units filled with concrete shall not be substituted. The unsupported height of isolated piers shall not exceed twelve times their least dimension.

SECTION 1410. *Beam Supports on Masonry Walls.*—(a) Joists, beams and other structural members shall not bear directly on hollow walls or walls of hollow units, but shall be supported on a sufficient number of courses of solid units or equivalent concrete or a metal plate or grillage sufficient to distribute the load to the webs and shells in such manner as not to exceed the allowable unit stress.

(b) Where structural steel beams or other metal members frame into exterior, party, fire or enclosure walls of masonry, the ends shall have protection against fire of the rating specified for the wall. Where wooden joists, beams or other combustible members

frame into such walls the ends shall be separated from the other side of the wall and from members framing into the other side of the wall by not less than four inches of masonry.

*SECTION 1411. Masonry Chases, Recesses, Corbels and Lintels.*—(a) There shall be no chases in masonry bearing or exterior walls eight inches or less in thickness or within the required area of a pier, and no chase in a bearing, exterior or fire wall or pier shall reduce the thickness thereof to less than eight inches. No horizontal or diagonal chase shall be allowed except subject to the limitations and conditions provided in this section for recesses.

(b) Recesses for stairways, elevators or other purposes may be made in masonry bearing, or exterior walls, but in no case shall the walls at such points be reduced to less than the thickness required in the fourth story. Such walls of reduced thickness shall have such additional lateral support as may be necessary. Recesses in masonry bearing or exterior walls for radiators and similar purposes, shall have not less than eight inches of masonry at the back. Such recesses shall be not more than eight feet in width unless the wall at the back may be considered a curtain or panel wall, and they shall then be arched over or spanned with lintels.

(c) No chases or recesses shall be permitted in fire or party walls that will reduce the thickness below the minimum specified in this code.

(d) Chases and recesses may be built as provided in this section, but shall not be cut in masonry walls of hollow masonry units or in hollow walls of brick.

(e) Chases shall be fire-stopped at floor and ceiling levels.

(f) Corbels may be built in masonry walls to furnish bearing for floors or roof but such corbels shall not project from the face of the wall more than one fourth the thickness of the wall nor more than one fourth the height of the corbel. Corbels shall be built with solid masonry units and thoroughly bonded to the wall. No corbel in a masonry wall less than twelve inches thick shall be used for the support of a floor or roof.

(g) Chimneys constructed of the same material as that of the wall, and lined as provided in Part 21, may be supported by corbels of which the projection is not more than one fourth the height nor more than the thickness of the wall, but no chimney shall be supported on a corbel from a wall less than twelve inches thick.

(h) Openings in masonry walls for doorways and windows shall have well buttressed arches or lintels of incombustible material. Structural or reinforcing steel in such lintels shall have protection against fire of the rating required for the wall, but not less than two-hour fire-resistive protection; except that the masonry over an opening may be supported by a steel plate, angle or similar member not fireproofed on the under side, if the width of the opening does not exceed six feet in bearing walls and ten feet in non-bearing walls, or if the member so unprotected is itself supported, at intervals not exceeding six feet in bearing walls and ten feet in non-bearing walls, from a beam or other adequate structure which has the required protection.

SECTION 1412. *Masonry Foundation Walls.*—

(a) Masonry foundation walls shall conform to the requirements for foundations of Part 29.

(b) Sand lime brick, gypsum tile and cinder concrete poured in place shall not be used in foundation walls nor as part of the required thickness thereof. Wood shall not be used in the foundations of permanent structures except as provided in Part 29.

(c) Rough or random rubble stone masonry without level beds shall not be used for foundation walls more than ten feet high or supporting buildings more than forty-five feet high.

(d) Masonry foundation walls shall be at least as thick as the wall supported, and not less than the following thickness:—

*Minimum Thickness (Inches) of Masonry Foundation Walls.*

Concrete	8
Solid masonry (except rubble)	8
Hollow masonry	12
Rubble masonry	20

(e) Foundation walls and retaining walls, which depend upon a floor or superimposed structure for resistance to overturning shall not be back-filled until so supported. Walls damaged by premature back-filling shall be removed and replaced if so required by the commissioner.

(f) Masonry foundation walls supporting wood shall be carried at least eight inches above adjoining ground and shall be effectually sealed to prevent moisture from reaching the wood through capillary action.

(g) Masonry in foundation walls shall be laid in cement mortar or cement-lime mortar.

SECTION 1413. *Parapet Walls.* — (a) In buildings of Type III, Type IV or Type VI construction not more than forty-five feet in height, party walls and fire walls shall extend through the roof not less than twelve inches, and in such buildings more than forty-five feet in height, not less than thirty inches. Masonry walls extending above the roof shall have a coping of incombustible material.

(b) In such buildings, exterior walls required by Parts 3 to 12, inclusive, to be of four-hour fire-resistant construction without openings shall extend above the roof, as provided in this section for party walls.

SECTION 1414. *Use of Existing Masonry Walls.* — An existing masonry wall may be used in the repair, alteration or enlargement of a building providing it meets the requirements of this code, and is structurally sound or can be made so by reasonable repairs. Existing masonry walls which are structurally sound but which are of insufficient thickness for their proposed use shall be strengthened by an addition of similar material not less than eight inches in thickness laid in mortar of required proportions. Foundations and lateral supports shall be provided as required for newly constructed walls under similar conditions. Such additions or linings shall be thoroughly bonded to the existing masonry by toothings bonded with the new masonry and built solidly into openings cut in the old masonry at least four inches deep. Such toothings shall be distributed uniformly throughout the wall and shall aggregate in vertical cross-sectional area not less than fifteen per cent of the total vertical area of the wall or

lining. If the existing wall is covered with plaster or other covering that might impair the bond of the lining, such covering shall be stripped off and the masonry cleaned. The repair, lining, or other strengthening of an existing masonry wall to be used in the repair, alteration or enlargement of a building shall be in every respect satisfactory to the commissioner and subject to such conditions as he may in any case prescribe.

SECTION 1415. *Masonry Veneer.* — (a) Unbonded masonry veneer may be used as a covering for a wall of any type of construction with or without air space. It shall not be regarded as a structural part of the wall or as contributing to its strength or stability, but it may serve as protection from the weather and where built without hollows or air spaces it may serve as protection for metal against fire. Gypsum shall not be used in veneer exposed to the weather.

(b) Masonry veneer shall be anchored to the backing, if of masonry, by headers or bond units, built at least three and one half inches into the backing, uniformly distributed, and having an area at least one fortieth the area of the wall, or by approved non-corrodible metal ties spaced not further apart than one foot, or three times the thickness of the veneer except that masonry veneer of thin flat stones on edge shall be anchored every twelve inches in all horizontal joints by non-corrodible anchors not less than one quarter inch in least dimension dowelled at least one inch into the top of veneer stones and well secured to the backing.

SECTION 1416. *Steel Frame Walls.*—(a) Walls framed with structural steel may be used for any of the functions described in section fourteen hundred and one.

(b) The frames of exterior steel frame bearing walls shall have fire protection of the rating specified for the exterior bearing walls of the building according to its type of construction in sections one hundred and twenty-six to one hundred and thirty, inclusive, of Part 1 and in Parts 3 to 12, inclusive.

(c) The frames of interior steel frame bearing walls shall have fire protection as required for structural steel columns in Parts 16 and 17.

(d) The frames of steel frame party walls shall have four-hour fire-resistive protection.

(e) The frames of steel frame curtain and panel walls shall have fire protection of the rating specified for such walls in section fourteen hundred and two and in Parts 3 to 12, inclusive.

(f) The frames of steel frame enclosure and fire walls shall have fire protection of the rating specified for the walls in Parts 3 to 13 inclusive and in Part 15.

(g) The steel frames of walls required by this section to be protected against fire shall not be supported upon wood or other combustible material nor upon metal with less protection than is required for such frames.

(h) The frames of steel frame exterior walls and other walls exposed to moisture shall be protected from rusting.

(i) Solid or hollow non-bearing partitions of steel frame and plaster shall have a total thickness not less than one sixtieth the height between lateral supports, nor less than two inches. The plaster of

hollow partitions shall be not less than three quarters inch thick. Vertical steel frame members shall be at least equivalent to twenty-four gage steel channels of a depth not less than half the thickness of the partition spaced not over twenty-four inches on centers.

(j) Except as otherwise specified in this section steel frame bearing or non-bearing walls may have frames of unprotected steel and panels of incombustible materials. Steel frame walls, bearing or non-bearing, with panels of combustible materials, may be used only where wooden frame walls are allowed by this code, except that in buildings of Type V, unprotected steel frame walls may have panels containing a layer of combustible insulating material between sheets of steel or equally protective covering.

**SECTION 1417. Wooden Frame Walls.**—(a) Wooden frame walls shall not be used for exterior walls except in buildings of Type VI construction nor for interior bearing walls except in buildings of Type IV or Type VI construction. Wooden frame walls shall not be used for party walls, fire walls, enclosure walls required to have greater than one-hour fire-resistance, nor for walls where incombustible materials are specified. Wooden frame walls shall not be used for foundation walls, nor for bearing partitions in basements or cellars.

(b) Wooden frame partitions shall not be used in buildings of Type I, Type II or Type V, except that in buildings of Type I and Type II, non-bearing partitions subdividing stores, offices, apartments or similar space occupied by one tenant may be of wood

or other combustible material. Such partitions shall not exceed five hundred linear feet within a single floor area separated from the rest of the story by one-hour fire-resistive partitions of incombustible materials. Hollow wooden frame partitions shall not be used in Type III buildings unless they are firestopped with incombustible materials throughout their entire height. Solid non-bearing partitions of wood or other combustible material may be used in a Type V building not exceeding fifty linear feet in a story and fire division.

(c) Wooden frame exterior walls shall have posts, sills and girts not smaller than three and one half by three and one half inches, except that when the studs are continuous through two stories the girt shall be replaced by a ledger board not less than three quarters by five and one half inches, housed into the studs. Posts shall be well braced the full story-height in all walls framed to them. Posts and girts shall be mortised, tenoned and pinned at each floor level, or connected by approved metal fastenings which provide equal rigidity. The space behind ledgers shall be firestopped with at least one and one half inch lumber cut between studs. In wooden stud exterior bearing walls more than one story high the studs shall be not over sixteen inches apart on centers and shall be bridged at least once at mid-height. At intersections between such walls and interior partitions, studs shall be well blocked, making what is commonly known as solid corners. Wall plates shall consist of two layers of wood not less than one and one half by three and one half inches. Studs shall be doubled beside openings, and the heads of such openings shall be trussed.

(d) Wooden stud bearing partitions shall have studs not less than one and one half by two and one half inches supported upon a girder or upon a sole plate not less than one and one half inches thick. The partition plate shall be not less than one and one half inches thick. Studs of a partition in an upper story over a partition below shall rest upon the plate of the lower partition and not upon the ends of the floor beams. Studs of wooden frame bearing partitions shall be bridged at least once at mid-height and studs supporting a floor shall be not more than sixteen inches apart on centers. Studs shall be doubled beside openings in partitions, and the heads of such openings shall be trussed. Wooden stud bearing partitions shall not be used to support more than a roof and three floors and in buildings three stories or more in height shall have one-hour fire-resistive rating.

(e) Hollow wooden frame walls and partitions shall be firestopped at floor and ceiling levels. Bearing partitions shall be firestopped the full height between ceiling and floor above. Firestopping shall consist of incombustible materials or of wood not less than one and one half inches thick.

(f) Exterior wooden frame bearing walls shall be covered on the outside with boarding nailed to the studs or with other approved material equally effective in stiffening the frame of the building. Boards shall be not less than three quarters inch thick unless a weather boarding is used, in which case it shall have an average thickness of at least five eighths inch. Each board shall have at least two nails to each stud. Stucco, masonry veneer and any material composed principally of gypsum shall not be

considered a satisfactory substitute for boarding on exterior wooden frame walls.

(g) Any other style of wall construction which provides stability, rigidity and fire-resistance equal to that of the walls specified in this section, as disclosed in tests prescribed by the commissioner and satisfactorily passed, may be used where wooden frame walls are allowed.

## PART 15.

### PROTECTION OF VERTICAL OPENINGS.

#### SECTION

- 1501 — Protection of Vertical Openings.
- 1502 — Trap Doors.
- 1503 — Enclosure of Vertical Openings.
- 1504 — Floor Construction within Enclosures.
- 1505 — Openings for Ventilation in Ventilating Shafts.
- 1506 — Ventilating Ducts.
- 1507 — Use of Enclosures.

#### SECTION 1501. *Protection of Vertical Openings.* —

(a) Where an opening in only one floor is required to be enclosed by provisions of Parts 3 to 12, inclusive, or by Part 18, it shall be enclosed either in the story above or in the story below, or protected by a trap door in such manner as to resist the spread of fire from one story to the other. Where a series of openings in two or more floors, required to be enclosed, are enclosed in one shaft, they shall be enclosed in all stories. A required exit shall not be closed by a trap door, except as otherwise provided in Part 18. The exterior walls of buildings are excluded from the provisions of this part, except as specifically provided in section fifteen hundred and three.

(b) Openings in floors which are not provided with

trap doors and are not enclosed in the story above, shall be protected by an adequate railing at least thirty inches high, and by a curb at the floor at least three inches high. Openings in roofs, unless covered by trap doors or skylights, shall be protected by an adequate railing or parapet at least thirty inches high.

**SECTION 1502. *Trap Doors.*** — (a) A trap door in a floor or roof shall be able to support its own weight and a concentrated load of two hundred pounds; and unless protected by a curb not less than six inches high or by a railing, shall be able to support a live load equal to that of the floor or roof in which it is placed. The requirements of this section shall not apply to stage construction in a theatre. A trap door in a floor shall be arranged to close automatically in case of fire in a manner satisfactory to the commissioner.

(b) In buildings of Type I and Type II construction a trap door shall not exceed six feet in either dimension, and shall have fire resistance equivalent to that of a Class A fire door as specified in Part 22.

(c) In buildings of a type of construction other than Type I or Type II, trap doors shall be of the construction required for the floor or roof, except that a trap door in a ceiling required to have fire resistance shall be equivalent in fire resistance to a Class A fire door as specified in Part 22 and shall not exceed six feet in either dimension.

(d) The commissioner may waive in part or modify the requirements of this section for protection of openings less than four square feet in area subject to such conditions as he shall in each case specify.

**SECTION 1503. *Enclosure of Vertical Openings.* —**

(a) In buildings of Type I, Type II or Type III construction, the required enclosure of a floor opening shall have two-hour fire-resistive rating.

(b) In buildings of Type IV construction, except as otherwise provided in this section, the required enclosure of a floor opening shall have not less than one-hour fire-resistive rating. In such buildings four stories or more in height and in such buildings three stories in height other than of Group H or Group I occupancy, such enclosures shall also be of incombustible materials. In buildings of Type IV construction more than three stories high an enclosure about both stairs and elevator shall have not less than two-hour fire-resistive rating.

(c) In buildings of Type V construction floor openings, if enclosed, shall be enclosed with incombustible materials.

(d) In buildings of Type VI construction, except as otherwise provided in this section, the enclosure of a floor opening where required, shall have not less than one-hour fire-resistive rating, and this provision shall apply to the inside face of that portion of an exterior wall which forms part of such an enclosure as well as to an interior wall.

(e) Combustible wainscoting, insulating or acoustical material may be attached to the walls of enclosures provided for in this section, but not within the enclosure, as specified in Part 14.

(f) Doorways in enclosures only about passenger elevators shall be protected by Class C fire doors or doors of incombustible materials in which glass shall be wire glass. Doorways in other enclosures of vertical openings shall be protected, in enclosures

required to have two-hour fire-resistive rating by Class B fire doors and in enclosures required to have one-hour rating by Class C fire doors, except as otherwise provided in Parts 3 to 12, inclusive. Window openings in required enclosures shall be protected by fire windows. Openings for ventilation in required enclosures shall be protected as provided in section fifteen hundred and five. Other openings in required enclosures shall be protected as the commissioner shall in each case specify.

(g) In required enclosures of floor openings, fire windows shall be fixed or automatic-closing; doors shall be self-closing or automatic-closing, except access doors for repairs which shall be kept closed and locked, and except doors in enclosures only about passenger elevators.

(h) The enclosure of chutes and dumb-waiters not exceeding four square feet in area need not have fire-resistive protection if constructed of metal not thinner than number sixteen gauge.

(i) Every elevator shaft and stairway enclosure, except dumb-waiter enclosures and enclosures in the interior of a building which do not serve the top story, shall be ventilated at the top by an opening to the outside air not less in area than one per cent of the area of the shaft. In addition, each such shaft shall have at the top means for emergency ventilation in the form of windows or skylights with thin plain glass, or in other approved form, not less in area than one quarter the area of the shaft.

**SECTION 1504. *Floor Construction within Enclosures.*** — Where the enclosure of floor openings is required by the provisions of Parts 3 to 12, inclu-

sive, or of this part to be of a construction more fire-resistant than the floors of the buildings or where such enclosure is required to be of incombustible materials, any portion of a floor of the building which shall form part of the enclosure, as when the walls thereof are offset in successive stories, shall be of materials and construction equivalent in fire resistance to that required for the walls.

**SECTION 1505. *Openings for Ventilation in Ventilating Shafts.*** — (a) Openings for ventilating purposes in enclosures, larger than one square foot in area, except as otherwise provided in this section shall be protected in one of the six following methods:—

(1) Louvres or dampers, which shall close by gravity or be held open by a fusible link so placed as to permit them to close in the case of fire.

(2) Openings into a shaft or duct used exclusively to exhaust the air from two or more stories may be protected by louvres which close by gravity, like a check valve, to prevent reversal of the air current.

(3) Openings into a shaft or duct used exclusively to supply air to two or more stories of a building may be protected by louvres which close by gravity, like a check valve, to prevent reversal of the air current.

(4) Openings in a ventilating shaft, connected with branch ducts at least as long as twelve times the larger transverse dimension of the duct need not have additional protection.

(5) An opening for ventilating exhaust in a shaft enclosure when connected to a duct without openings in other stories, leading to a point above the

roof level, need not have the protection of automatic-closing louvres or dampers.

(6) An opening for the supply of air to a ventilated space which is connected by means of a duct without openings in other stories to a fan, plenum chamber or other source of air supply, need not have the protection of automatically closing louvres or dampers.

**SECTION 1506. *Ventilating Ducts.*** — (a) Ventilating ducts in all buildings shall be of incombustible materials, but may be lined with fibrous insulating or sound deadening material which has been chemically treated, if necessary, so that it will not by itself support combustion. Horizontal offsets of vertical ducts shall be protected in Type I and Type II buildings by at least one-hour fire-resistive construction of incombustible materials.

(b) The combustible material of partitions and floors through which sheet metal ventilating ducts pass shall be kept at least one inch from the metal or be protected by not less than one half inch of plaster or one quarter inch of asbestos board or other incombustible material of equal insulating value. Openings between sheet metal ventilating ducts and combustible floor construction through which they pass shall be fire stopped with incombustible material.

**SECTION 1507. *Use of Enclosures.*** — Except as otherwise specifically provided, no limitation is imposed in this chapter upon the shape or size of the enclosure in any story of a vertical opening, but the area within a stairway shall not be used for storage

or manufacturing, or within any enclosure for other than the purpose or purposes for which the vertical opening was constructed, but this provision shall not be held to prevent the placing of electrical cabinets, piping, fire extinguishing apparatus and the like, in vertical enclosures in such manner as shall not interfere with its required use. A corridor serving as a passageway to two remote exits from a story shall be separated from such exits, if enclosed, by the enclosure thereof.

## PART 16.

### FLOOR CONSTRUCTION.

#### SECTION

- 1601 — Floor Construction.
- 1602 — Type I: Fireproof Floor Construction.
- 1603 — Type II: Semi-Fireproof Floor Construction.
- 1604 — Type III: Heavy Timber Floor Construction.
- 1605 — Type IV: Light Wooden Floor Construction.
- 1606 — Type V: Metal Frame Floor Construction.
- 1607 — Type VI: Wooden Frame Floor Construction.
- 1608 — Ratproofing.

SECTION 1601. *Floor Construction.* — The floor construction in all buildings shall conform to the requirements of other chapters of this code as to structural design, quality and strength of materials. Floors shall be so constructed as to afford to walls, columns, piers, beams and other supporting members the lateral support which is required for their stability.

SECTION 1602. *Type I: Fireproof Floor Construction.* — (a) In buildings of Type I construction the floors shall be of steel, reinforced concrete, brick or structural clay tile arches, reinforced gypsum, or

of combinations of these materials or other approved system of floor construction, and shall be of not less than three-hour fire-resistive construction as provided in Part 22. Floor beams which are spaced not further apart than half the spacing of columns, including in this case those connected to columns, may be considered as a part of the floor and not of the building frame for purposes of this section.

(b) In buildings of Type I construction columns and framing supporting floors, where they are not supported on masonry walls or piers, and such members of the floor framing as are connected to columns or necessary for the stability of columns, except as otherwise provided in this section, shall be of structural steel protected by not less than four-hour fire-resistive protection or of reinforced concrete the reinforcement of which is so protected, except that fire protection need not be provided on steel or iron forms, on lintels not more than six feet in span in bearing masonry walls and not more than ten feet in span in non-bearing masonry walls, on supports for elevator guides and elevator machines except where they support other loads or brace the floor framing, on the metal framing of mezzanine floors which may be of wood as specified in this section, or on the landings of enclosed stairways.

(c) Floors in Type I buildings may be covered with wood or other combustible flooring. Where wooden sleepers are used for laying wooden floors the space between the structural floor and the flooring shall be filled solidly with incombustible material under corridor and permanent partitions and elsewhere on continuous lines for at least a foot in width in such manner that there will be no hollow spaces

under the flooring exceeding one thousand square feet in area. Wooden flooring shall not underlie enclosure, or toilet room partitions, nor masonry partitions.

(d) Mezzanine floors in Type I buildings may be of wood or unprotected metal provided there are not more than two such mezzanines in any one room, the total area of the mezzanines does not exceed one third the area of the room or five hundred square feet, and one is not above the other.

(e) The fire protective material required for structural steel shall preferably be applied directly to the metal but structural steel members enclosed in spaces not over five thousand square feet in horizontal area, which are protected above, below and on all sides by ceilings, floors and walls of four-hour fire-resistive construction and are unoccupied and inaccessible except in emergency, need not have other fire protection.

(f) Ceilings in Type I buildings may be finished in wood or other combustible but not highly flammable material for ornamental, insulating, acoustical or similar purposes. Such material, with similar material on walls and partitions, shall not exceed ten pounds per square foot of floor area nor five thousand pounds in all within any floor space enclosed by exterior walls and partitions of one-hour fire-resistive construction nor ten thousand pounds in all within any space enclosed by exterior walls and partitions of two-hour fire-resistive construction, unless it is so treated chemically that it will not, by itself, support combustion.

SECTION 1603. *Type II: Semi-Fireproof Floor Construction.* — (a) In buildings of Type II con-

struction the floors shall be of incombustible materials and structural metal shall have one-hour fire-resistive protection. Floor beams which are spaced not further apart than half the spacing of columns, including in this case those connected to columns, may be considered as a part of the floor and not of the building frame for purposes of this section.

(b) In buildings of Type II construction columns and framing supporting floors, where they are not supported on masonry walls or piers, and such members of the floor frame as are connected to columns or necessary for the stability of columns, except as otherwise provided in this section, shall be of structural steel protected by not less than two-hour fire-resistive protection or of reinforced concrete the reinforcement of which is so protected, except that fire protection need not be provided on steel or iron forms, on lintels not more than six feet in span in masonry bearing walls and not more than ten feet in span in non-bearing masonry walls, on supports for elevator guides or elevator machines except where they support other loads or brace the floor framing, or on the landings of enclosed stairways.

(c) Floors in Type II buildings may be covered with wood or other combustible flooring as provided in section sixteen hundred and two for Type I buildings.

(d) The fire protective material required for structural steel shall preferably be applied directly to the metal but structural steel members enclosed in spaces not over three thousand square feet in horizontal area, which are protected above, below and on all sides by ceilings, floors and walls of two-hour fire-resistive construction, and are unoccupied and

inaccessible except in emergency, need not have other fire protection.

(e) Floor construction which consists of steel or other incombustible beams or joists, spaced not more than the thirty-six inches on centers, supporting a floor of reinforced concrete, steel plate or other incombustible materials, and protected on the under side by an incombustible ceiling of one-hour fire-resistive construction shall be considered as meeting the requirements of this section. Enclosed spaces formed by such a ceiling shall not exceed five hundred square feet in horizontal area within incombustible fire stops of one-hour fire-resistive construction.

(f) Ceilings in Type II buildings may be finished in wood or other combustible but not highly flammable material for ornamental, insulating, acoustical or similar purposes. Such material, with similar material on walls and partitions, shall not exceed six pounds per square foot of floor area nor three thousand pounds in all within any space enclosed by exterior walls and partitions of not less than one-hour fire-resistive incombustible construction, except that in a room where the ceiling is of three-hour fire-resistive construction and the enclosing walls, other than exterior walls are of two-hour fire-resistive construction, the amount of such combustible material shall not exceed ten pounds per square foot of floor area nor ten thousand pounds in all.

SECTION 1604. *Type III: Heavy Timber Floor Construction.* — (a) In buildings of Type III construction the floor planking, if of wood, shall be not less than one and five eighths inches thick, tongued

and grooved or splined, and fire-stopped by a continuous layer of asbestos fabric or other approved fire-resistive material, covered with wooden flooring not less than three quarters inch thick, or equivalent protective flooring. Enclosed or concealed spaces shall be avoided.

(b) Laminated floor construction consisting of lumber not less than one and one half inches nor more than three inches thick placed on edge, and securely spiked together, making a floor not less than three and one half inches thick, may be used in place of planking.

(c) Floor beams in buildings of Type III construction, except as otherwise provided in this section, shall be of structural timber not less than five inches in least dimension nor less than forty square inches in cross-sectional area, but this limitation shall not apply to nailing strips supported on masonry, structural steel or the like.

(d) Columns supporting floors in buildings of Type III construction shall be of structural timber not less than seven inches in least dimension or of steel protected as specified in this section. Column caps for the support of beams and girders shall be of cast iron, steel or reinforced concrete, except that wooden bolsters may be used on columns supporting not more than a roof and one floor. Columns shall not rest upon the ends of wooden beams. Wood shall not be used for columns in basements or cellars.

(e) The metal of steel column caps or of stirrups supporting beams or girders shall not be thinner than three sixteenths inch nor shall that of cast iron caps be thinner than one half inch.

(f) Timbers supported on masonry walls shall be bevelled so that they may fall free of the wall in case of fire.

(g) Structural steel I-beams or columns of H section may be used instead of timber provided they are fireproofed by filling the space between flanges solidly with concrete or masonry held in place by ties through or secured to the web, or by enclosing the exposed faces in one-hour fire-resistive protection. Other structural steel shapes may be used for beams or columns, protected by one-hour fire-resistive protection. Standard weight steel pipe filled with concrete may be used for columns in buildings of Type III construction.

(h) Floors shall be anchored to exterior and bearing walls and the beams thereof shall be connected to form continuous ties from wall to wall sufficient to resist the wind pressure specified in Part 23 applied outwardly to the walls.

(i) Structural masonry and reinforced concrete shall not be supported upon wooden floor constructions, but this restriction shall not apply to fire-stopping, the protective foundations under heat-producing apparatus or to tile or concrete flooring with its base not more than four inches in total thickness, laid upon the planking.

SECTION 1605. *Type IV: Light Wooden Floor Construction.* — (a) In buildings of Type IV construction the floors may be of wood unprotected against fire. Floor beams and joists of wood shall not be less than one and five eighths inches thick. Where joists frame on a girder or bearing partition

on both sides thereof, the spacers between the joists shall be fire-stopped with incombustible materials or with wood not less than one and one half inches thick.

(b) Floors may be supported upon the masonry walls of the building or upon wooden columns or bearing partitions. Structural steel beams, steel or iron columns without protection against fire, reinforced concrete or other approved materials may be used in the floor framing or for its support. Wood shall not be used for columns or bearing partitions in basements or cellars.

(c) Timbers supported on masonry walls shall be bevelled so that they may fall free of the wall in case of fire.

(d) Floors shall be anchored to exterior and bearing walls and the beams thereof shall be connected to form continuous ties from wall to wall sufficient to resist the wind pressure specified in Part 23 applied outwardly to the walls.

(e) Structural masonry and reinforced concrete shall not be supported upon wooden floor construction, but this restriction shall not apply to fire-stopping, the protective foundations under heat-producing apparatus or to tile or concrete flooring with its base not more than four inches in total thickness, laid upon the boarding.

SECTION 1606. *Type V: Metal Frame Floor Construction.* — In buildings of Type V construction the floors shall be constructed of incombustible materials. Structural steel or iron floor plates, structural steel beams, or steel or iron columns supporting floors need not be protected against fire.

SECTION 1607. *Type VI: Wooden Frame Floor Construction.* — (a) In buildings of Type VI construction the floors may be of wood unprotected against fire. Floor beams and joists of wood shall be not less than one and five eighths inches thick. Where joists frame on a girder or bearing partition on both sides thereof, the spaces between the joists shall be fire-stopped with incombustible materials or with wood not less than one and one half inches thick.

(b) Floors may be supported upon the walls of the building or upon wooden columns or bearing partitions. Structural steel beams or steel or iron columns without protection against fire, reinforced concrete or other approved materials may be used in the floor framing or for its support. Wood shall not be used for columns or bearing partitions in a basement or cellar.

(c) Structural masonry and reinforced concrete shall not be supported upon wooden floor construction, but this restriction shall not apply to fire-stopping, the protective foundations under heat-producing apparatus or to tile or concrete flooring with its base not more than four inches in total thickness, laid upon the under boarding.

SECTION 1608. *Ratproofing.* — (a) Every basement or cellar in buildings hereafter erected shall be completely covered with a ratproof floor of concrete, or solid masonry laid in cement mortar, not less than two inches thick, or other approved flooring. Pits or openings in such floors shall be lined on all sides and the bottom with similar material.

(b) Recesses and inaccessible spaces where rats

might find refuge and breed shall be avoided if possible, and otherwise shall be sealed with masonry or with substantial wire mesh of incorrodible metal.

## PART 17.

### ROOF CONSTRUCTION AND COVERING.

#### SECTION

- 1701 — Roof Construction.
- 1702 — Roof Covering.
- 1703 — Roof Drainage.

SECTION 1701. *Roof Construction.* — (a) Except as otherwise provided in this part, in so far as they are pertinent, the provisions of Part 16 for the construction of floors and their supports shall also apply to the construction of roofs of buildings of the respective types of construction.

(b) Members of structural steel frames of roofs and other incombustible roof construction covered with fire-retardant roofing, on Type I and Type II buildings, over auditoriums and assembly halls and over approved rooms of Group G occupancy shall be deemed to be sufficiently protected against fire if they are not less than twenty-five feet distant from the floor, and from a mezzanine floor or balcony below; or if they are not less than eighteen feet so distant and are protected by an incombustible ceiling of one-hour fire-resistive construction suspended at least one inch below the steel. Proximity within these limiting distances of an inclined or stepped balcony with fixed seats, or of a mezzanine floor or level balcony not more than five feet wide, shall not be grounds for requiring greater fire protection than is required in this paragraph. The ceilings of such

rooms and the walls more than five feet above the floor shall not be covered or finished with combustible material.

(c) Filling for drainage on the roof of a building of Type I, Type II and Type V construction shall be of incombustible material except that wood, in amount not more than two board feet per square foot, may be used on a roof of Type I or Type II construction designed for a future floor. Filling for thermal insulation may be of combustible but not highly flammable material laid without air space.

(d) In buildings of Type III the roof planking, if of wood, shall be not less than one and one half inches thick. Wooden columns supporting a roof in a building of Type III construction shall be not less than five inches in least dimension.

(e) In buildings of Type III, Type IV and Type VI construction where the exterior wall is required by Parts 3 to 12, inclusive, to be of fire-resistive construction without unprotected openings, wooden joists, rafters and other combustible roof construction shall not extend through or across the exterior wall, except the roof boarding, planking or a nailing piece, which shall then be covered with metal. Such walls shall extend up to the under side of the roof boarding or planking and where required by Parts 3 to 12, inclusive, to be of four-hour fire-resistive construction without openings, shall have parapets above the roof as specified in Part 14. Where such walls may have unprotected openings combustible roof construction may project not more than one foot to form eaves except in the first and second fire zones.

SECTION 1702. *Roof Covering.* — Roof covering

on buildings of Type I, Type II or Type V shall be either fire-retardant or ordinary roofings as specified in Part 22. Roof covering on buildings of Type III, Type IV or Type VI shall be fire-retardant.

SECTION 1703. *Roof Drainage.*—(a) Roofs of buildings and of all parts thereof shall be sloped to drain at a pitch of not less than one inch in ten feet. Gutters and conductors or leaders shall be provided at the low points to which water will flow, except on one story or two story buildings not over six hundred and fifty square feet in area, with drains to lead away and satisfactorily to dispose of rain water. Means shall be provided to prevent rain water from any part of a building except window sills, copings and cornices not more than one foot wide and awnings or marquises discharging off the outer edge, from filling or flowing upon a public way.

(b) Where a roof is finished with a smooth surface of tile, terrazzo or similar material and under other favorable circumstances, the commissioner may waive the requirement of a slope and permit construction of a level roof subject to such conditions as he shall in any case specify.

(c) No part of any roof shall be so constructed as to discharge snow or ice upon a public way.

(d) Rain water leaders shall not be discharged upon a public way nor upon land of another owner, nor so as to flow upon such public way or land.

(e) This section shall not be held to prevent the construction of a spray pond on a roof or the use of a roof to contain water for industrial or other approved purposes provided it is not allowed to become stagnant.

## PART 18.

## EXITS.

## SECTION

- 1801 — General Requirements for Exits.
- 1802 — Kinds of Exits.
- 1803 — Number of Occupancies.
- 1804 — Number and Location of Exits.
- 1805 — Corridors and Passageways.
- 1806 — Doorways as Exits.
- 1807 — Windows as Exits.
- 1808 — Interior Stairway.
- 1809 — Interior Ramps.
- 1810 — Smokeproof Towers.
- 1811 — Exterior Stairways or Ramps.
- 1812 — Fire Escapes.
- 1813 — Ladders as Exits.
- 1814 — Elevators as Exits.
- 1815 — Horizontal Exits.
- 1816 — Other Exits.
- 1817 — Exit Enclosures.
- 1818 — Exit Signs.
- 1819 — Exit Maintenance and Lighting.

SECTION 1801. *General Requirements for Exits.*

— Every new building and every portion thereof shall have exits in conformity with this part and Parts 3 to 12, inclusive. No building shall be enlarged, altered or repaired in such manner as to reduce the number or capacity of exits to less than required nor shall the occupancy be changed unless the exits conform or are made to conform to the requirements for the new occupancy.

SECTION 1802. *Kinds of Exits.* — (a) An exit from a room may be either —

- (1) A doorway.
- (2) A window.
- (3) An exit from a story.
- (b) An exit from a story may be either —

- (1) An interior stairway.
- (2) An interior ramp.
- (3) A smokeproof tower.
- (4) An exterior stairway or ramp.
- (5) A fire escape.
- (6) A ladder.
- (7) Elevators.
- (8) An exit from the building or from the fire division.
  - (c) An exit from a building or from the fire division may be either —
    - (1) A doorway in the exterior wall of the building opening upon a street or an open space with access to a street.
    - (2) A horizontal exit.
  - (d) All exits shall be of the kinds listed in the preceding paragraphs of this section subject to the limitations and requirements of this part, except that where two exits are required the commissioner may permit the substitution for one of them of sliding poles, chutes or other means of egress when all the persons who may in emergency need to use such means of egress are trained to their use in their daily occupations and when all other relevant conditions are satisfactory to the commissioner.
  - (e) No exit of any kind may serve as a required exit unless it is or forms part of a continuous path of exit from the floor space served to the street.
  - (f) At least one exit from every story of a building, except a basement, cellar, first or second story from which there is a doorway exit to a street or to an open space accessible to a street, shall be an interior stairway, an interior ramp or a smokeproof tower.

SECTION 1803. *Number of Occupancies.* — (a) When the number of persons to be served by an exit is not stated in the application for permit and is not otherwise determined, the number shall be computed from the floor area assuming the number of occupants as follows:—

- (1) One person for every six square feet in auditoriums, assembly halls, dance halls, gymnasiums, armories, lodge rooms.
- (2) One person for every fifteen square feet in court rooms, restaurants, class rooms in schools.
- (3) One person for every twenty-five square feet in retail stores, lodging houses, reading rooms.
- (4) One person for every thirty-five square feet in factories and work rooms.
- (5) One person for every fifty square feet in offices and show rooms.
- (6) One person for every one hundred square feet in Group D buildings, hotels, apartments and other dwellings, police and fire stations.
- (7) One person for every two hundred square feet in automobile repair shops and service rooms, museums, libraries, wholesale stores, and club houses, except in assembly halls thereof.
- (8) One person for every thousand square feet in storage garages and warehouses.

(b) For other occupancies the commissioner shall determine the ratio of occupants to floor area in each case.

(c) If the number of occupants stated in an application for permit is clearly less than the number commonly to be found in other buildings of the same occupancy, the commissioner shall determine the number of occupants, not in excess of the number

computed in accordance with paragraph (a) of this section, and shall require exits conforming thereto.

(d) Where the kind or width of an exit depends upon the number of persons served by it, such number shall be determined by dividing the maximum number of persons in any room or group of rooms, or in any story and within a fire division, by the number of alternative exits to which they all have access less one (assuming that one such exit may be blocked) except where only one exit is required.

*SECTION 1804. Number and Location of Exits.* —

(a) Except as otherwise specified in Parts 3 to 12, inclusive, buildings and parts thereof shall have at least the number of exits required in this section. The kinds of exits provided, as required in this part, shall be subject to the limitations imposed by sections eighteen hundred and five to eighteen hundred and sixteen inclusive.

(b) Every room and group of less than four rooms shall have at least one exit conforming to the requirements of this chapter. The exit from an attic or similar enclosed space, accessible but normally unoccupied, may be a scuttle not less than two feet by three feet in the ceiling of the story below. Such scuttle shall, if required by the commissioner, be provided with a permanent ladder. The flat roof of a building, if occupied by persons, shall be considered a room and a story for the purposes of this section.

(c) Every room or group of rooms containing in the aggregate more than twenty-five hundred square feet of floor area or seventy-five occupants and every group of four or more rooms, except an attic or similar enclosed space, accessible but normally

unoccupied, shall have at least two remote exits. Such exits may open into a common corridor which has at least two remote exits. Closets, vestibules, toilet rooms and the like shall not be counted as rooms of a group for the purpose of this paragraph.

(d) When a story of a building is occupied by two or more tenants, each tenant shall have access to at least two remote exits from the story.

(e) In buildings other than of Group I less than three stories in height every story shall have at least two remote exits, except that a basement or cellar used only for low pressure heating apparatus or other similar use (but not storage) not requiring attendance of more than two persons, and not over one thousand square feet in area need have but one exit.

(f) Every room or story required to have two remote exits shall have two remote and independent paths of exit of the required width at all points.

(g) A single exit from a room or group of rooms which has no other exit shall not be further than sixty feet from any point within the room or rooms measured along the path of exit.

(h) Where two or more exits from a room are required they shall be remote or distant from one another in such manner that persons in any place may choose either of two directions in a path toward an exit and in such manner that a single fire could not in its early stages block both paths toward an exit. The distance from any point in a room to the nearest exit shall not exceed one hundred and fifty feet in buildings of Type I, Type II and Type V nor seventy-five feet in buildings of Type III, Type IV and Type VI.

(i) The exits from a story in a fire division shall be of such number and so located that at least one such exit is within one hundred and fifty feet in buildings of Type I, Type II and Type V, and within seventy-five feet in buildings of Type III, Type IV and Type VI, from every exit from a room or group of rooms into a corridor or, in a story without a corridor, from every point within the story and fire division. The distance to an exit, if a doorway, shall be measured to the nearer jamb thereof; if an enclosed stairway or ramp, to the doorway in the enclosure; and if a stairway or ramp not enclosed, to the nearest point of the top riser or commencement of slope.

SECTION 1805. *Corridors and Passageways.* — (a) A passageway shall be provided and maintained in every story of a building from all parts of the floor to the required exits, of width not less than the required width of the exit to which each leads, nor less than twelve inches for every one hundred persons served.

(b) Corridors may serve as exits from the doorways from rooms to exits from the story. The clear exit width of corridors shall be not less than the required width of any doorway from which it leads, nor of the exit to which it leads, nor less than thirty-six inches nor less than twelve inches for every one hundred persons served.

(c) Neither radiators nor pipes, doors in an open position nor any other equipment or construction shall be allowed to reduce or encroach upon the required width of a corridor. If lockers are placed along one or both sides of a corridor its clear width

between lockers shall be increased over its required exit width by eighteen inches for each side on which lockers are placed and if other use than egress and lockers is made of corridors, the clear width shall similarly be increased over its required exit width as the commissioner shall in each case determine.

(d) Passageways which serve as exits from enclosed stairways or ramps to exits from the building shall be enclosed corridors except from one stairway or ramp in the first story of retail stores not over two thousand square feet in area where the floor is of Type I construction and the first story and basement are equipped with automatic sprinklers.

(e) The clear width of such passageways shall be not less than required for the stairway or ramp nor less than twelve inches for every one hundred persons in any story of the building served. The clear height shall be not less than seventy-eight inches.

(f) The floor and walls of a corridor serving as an exit from an enclosed stairway or ramp shall have fire-resistance of the rating required for the enclosure and the ceiling shall be of one-hour fire-resistive construction.

(g) The floor of such a corridor shall be level or shall slope not over one vertical in ten horizontal, but such floor shall be level for a distance of forty-four inches from a stairway and at all doorways or connecting corridors for the full width thereof and one foot additional on each side.

(h) An outside passageway leading from an exit from a building to a street shall have the clear width required for an interior passageway, and if covered shall be covered by incombustible construction.

Such passageway shall be subject to all pertinent requirements for exits.

**SECTION 1806. *Doorways as Exits.*** — (a) Doorways which serve as required exits shall be not less than twenty inches wide. Doorways which serve as exits for more than ten persons shall be not less than seventy-eight inches high nor less than thirty inches wide nor less than twelve inches in width for every hundred persons so served.

(b) The floor both sides of a doorway exit shall be at the same level except that in doorway exits from a building out-of-doors there may be a single step down not over six inches to a landing not less than three feet wide, and in other exit doorways there may be not more than a single step up in the direction of egress not over eight inches high, the landing each side being at least three feet wide, and except as otherwise specified in this chapter.

(c) Thresholds in exit doorways shall not be over one inch high.

(d) In enclosures of stairways or ramps which serve as required exits, doors shall swing in the direction of egress.

(e) Except in buildings of Group H and Group I, swinging doors in doorways which serve as required exits from the building and serve more than two stories shall swing in the direction of egress.

(f) Revolving doors in required exits shall be of approved panic type and each such door may be counted as an exit for not over two hundred and fifty persons.

(g) Except in detention buildings, doors in required exits shall not be so locked or fastened that

they cannot be opened from the inside without use of a key.

SECTION 1807. *Windows as Exits.* — A window shall not serve as an exit except in an existing building and in such case only as the second of two required exits serving not more than ten persons and subject to the approval of the commissioner and to such conditions as he may in each case prescribe. This provision shall not be held to limit the use of glass in a door.

SECTION 1808. *Interior Stairway.* — (a) Interior stairways may serve as exits from any story of a building. Except as otherwise provided in this section, every interior stairway required to be enclosed shall have a direct doorway exit from the building or shall have an enclosed corridor leading to such exit. In retail stores not over two thousand square feet in area, one stairway required to be enclosed need not have an enclosed corridor exit in the first story if the first floor is of Type I construction and the first story and basement are equipped with automatic sprinklers.

(b) In buildings more than three stories high with flat roofs at least one interior stairway or ramp shall extend to the roof; and where more than two stairways or ramps serve as required exits, at least two shall be interior stairways or ramps which shall extend to the roof. In such buildings more than three hundred feet long there shall be at least two remote stairways or ramps extending to the roof. In a two-story or three-story building with flat roof, unless a stairway extends to the roof, there shall be

a scuttle in the roof, not less than two feet by three feet, with a ladder, near a stairway.

(c) An interior stairway shall be located entirely within the exterior walls of a building, but this requirement shall not be held to constrain the shape or plan of the exterior walls or the construction of the enclosure wall.

(d) No interior stairway serving as a required exit shall be less than twenty-four inches wide. No such stairway serving as a required exit for twenty-five or more persons shall be less than thirty-six inches wide nor less than twelve inches for every one hundred persons so served. The width of stairs shall be measured in the clear between walls, balustrade, hand rails, newel posts or other limiting construction. The clear vertical headroom over each riser shall be not less than seven feet.

(e) Interior stairways shall be enclosed where so required in Parts 3 to 12, inclusive, and in Part 15 of this code.

(f) In buildings of Type I, Type II or Type V interior stairs including landings, and in buildings of Type III or Type IV over three stories high, stairs which serve required exits shall be constructed of incombustible materials, except that stairs with solid treads, risers and landings of incombustible materials may have top surfaces of wood, linoleum or other similarly combustible material. Treads, risers or landings of marble, slate or similarly brittle material shall be backed with sheet steel, for stairs three feet or less in width of at least number twelve gage, and for wider stairs at least number ten gage. Cast iron shall have a thickness of at least three sixteenths inch in treads and risers and three eighths

inch in landings. Cast iron landings shall not have greater area than nine square feet between steel or other supports. Enclosed metal stairs and landings need not be protected against fire. Stairs which are not enclosed as provided in Part 15, in buildings of Type I or Type II shall have protection against fire as specified for floors.

(g) In buildings of Type III, Type IV or Type VI not over three stories high, stairs, including landings, may be of wood. In buildings of Type III wooden stairs which are not enclosed as provided in Part 15 shall have treads at least one and one half inches thick; the risers, if any, shall be one and one half inches thick; stringers shall be not less than three and one half inches in least dimension; and the stairs shall be constructed without concealed spaces. Wooden stairs with soffits enclosed by plaster, sheathing or otherwise, shall be fire-stopped at floors and landings and not further apart than at every eighth riser with incombustible material or with wood not less than one and one half inches thick.

(h) Treads and risers of stairs serving as required exits, except in schools, shall be so proportioned that the product of the tread and the rise in inches shall be not less than seventy nor more than seventy-seven; and the treads shall not be less than nine and one half inches nor the rise more than seven and three quarters inches. In schools, the treads and risers may be proportioned, with the approval of the commissioner, to suit the age of the pupils. Treads and risers shall be uniform throughout any one flight.

(i) No flight of stairs shall have more than fifteen nor less than two risers between landings. A landing between two flights of stairs in the same

direction shall be at least as wide as the stairs and at least three feet long in the direction of travel. Stairs turning at a right angle shall have a square or rectangular landing the full width of the respective stairways. Where stairs return directly on themselves, a landing without steps shall be provided at least as wide as the stairs.

(j) Winders and spiral stairs shall not be used in a stairway serving as a required exit for twenty-five persons or more nor in stairways more than one story in height, except in existing buildings with the approval of the commissioner. Stairs may be curved if the tread and rise one foot from the inner rail are as specified in this section and the tread at the outer rail is not more than twice the tread one foot from the inner rail.

(k) Where stairs and landings are not guarded at the side by a wall or partition, they shall have a railing, balustrade, grille or similar guard at least thirty-three inches high at the face of the riser. In case a stairway more than two stories high has recurring flights and landings about an interior well more than twelve inches wide in horizontal projection, the guard next the well shall be not less than three feet high at the face of the riser, and shall consist, if a railing, of at least two rails, if a balustrade, of balusters not over six inches apart, and if a grille or other form of guard, of meshes not more than six inches in least dimension, and the edge of the stairs and of the landings shall have a curb at least three inches high.

(l) Stairs less than forty-four inches wide shall have a handrail on one side; stairs forty-four inches wide or more and curved stairs shall have handrails

on both sides. Where the width of a stairway is required, as an exit, to exceed eighty-eight inches one or more intermediate handrails shall be provided not over eighty-eight inches apart. Handrails shall be about three feet high above the center of the treads, shall be continuous between landings and in stairways which serve as required exits, handrails which are not continuous shall be returned at the upper end to the wall or terminate at a post in such manner as not to leave a free or projecting end. Handrails may be of wood.

(m) Slippery materials shall not be used in the treads and landings of stairways which serve as required exits nor shall such treads or landings be allowed to become slippery by the accumulation of oil, grease, graphite or otherwise.

(n) No pipe, radiator or other equipment shall obstruct or encroach upon the required width of a stairway or landing. No stairway which serves as a required exit shall be obstructed while the building is occupied, within the enclosure thereof, on the steps or landings or on the floors within the area required for exit or for approach to the stairway, by materials, equipment or by any use of such space except for passage.

(o) There shall be no closet within the required enclosure of a stairway. There shall be no closet for storage under a stairway of combustible material which is a required exit except a coat closet in dwellings or a toilet or similarly non-hazardous use, and in such case the soffit of the stairway shall be protected by a ceiling of one-hour fire-resistive construction.

SECTION 1809. *Interior Ramps.* — (a) Interior ramps may serve as exits from any story of a building.

(b) An interior ramp shall be located entirely within the exterior walls of a building.

(c) The width, enclosure, guarding and construction of ramps shall be the same as provided for interior stairways. All requirements for interior stairways which are pertinent shall also apply to interior ramps except the requirement for hand-rails.

(d) Ramps which serve as required exits shall not have a slope greater than one vertical in ten horizontal.

(e) Ramps may be straight or curved in plan or a combination of straight or curved portions. Lines on the floor of straight ramps at right angles to the direction of egress shall be horizontal. Radial lines on the floor of a curved ramp shall be horizontal or raised not over one inch per foot of the width measured from the inside of the curve. The slope of curved ramps shall be measured two feet from the inner wall or railing.

(f) Ramps which serve as required exits shall be surfaced with approved non-slip material.

SECTION 1810. *Smokeproof Towers.* — (a) In buildings more than one hundred feet high at least one exit from every story above the tenth or more than one hundred feet above the ground shall be a smokeproof tower. Smokeproof towers may also serve as exits from any story of a building.

(b) A smokeproof tower shall consist of an interior, enclosed stairway or ramp of incombustible materials

to which egress from a story of the building is had by means of a vestibule open to the outer air.

(c) There shall be no openings in the walls separating a smokeproof tower from the remainder of the building except the doorways of the vestibule specified in paragraph (b) of this section. A smokeproof tower shall extend, directly or by means of connecting corridors in any story, to an exit to the street, except that a smokeproof tower serving the upper stories of a building may be connected, in its lowest story, by means of an open vestibule, with an interior enclosed stairway which has an exit to the street. Such a tower shall be separated from the interior stairway by an incombustible separation of at least one-hour fire-resistive rating, without openings.

(d) The vestibule of a smokeproof tower shall be ventilated by an opening upon a street or upon a court not less than ten feet wide nor less than one hundred and fifty square feet in area and not nearer than ten feet from a property line other than a street line. The opening shall be at least the full width of one side of the vestibule, extending from the ceiling at least half the distance to the floor, without window, shutters or other covering. Unless windows in the exterior walls of a smokeproof tower open upon a street or upon an open court fifteen feet or more from a property line or from openings in another wall, they shall be protected by fire windows.

(e) The vestibule may be either inside or outside the exterior walls of the building. The floor shall be of solid fireproof construction, either level with the floor of the building in each story or not more than one six-inch step down from the floor, and the adjoining stair landing shall be level with the floor

of the vestibule. Openings for doorways or windows in the exterior wall of the building under or within five feet from such vestibule shall be protected by automatic-closing Class B fire doors or fire windows.

(f) The open side or sides of the vestibule shall be guarded by a railing not less than forty-two inches high, with an intermediate rail, balustrade, grille or wall.

(g) Doorways of the vestibule shall have self-closing Class B fire doors swinging in the direction of egress. The clear width of the doorways and of the vestibule shall be not less than the width required for the exit.

**SECTION 1811. *Exterior Stairways or Ramps.* —**

(a) Exterior stairways or ramps may serve as required exits from any story or stories of a building. Except as to enclosure and location within the exterior walls of a building, an exterior stairway or ramp shall conform to the requirements for interior stairways or ramps, respectively. Exterior stairways or ramps shall be located outside the exterior walls of a building, but not nearer than five feet from a lot line other than a street line.

(b) Exterior stairways or ramps serving as required exits, and their landings, railings and enclosures, if any, shall be of incombustible materials except on buildings of Type VI construction and except that handrails may be of wood.

(c) A doorway serving as an exit from a story to an exterior stairway or ramp shall open upon a landing level with or not more than one six-inch step below the floor, and shall be protected except in buildings of Type VI construction by a self-closing

Class B fire door. Openings for doorways or windows under or within five feet from an exterior stairway or ramp, except in buildings of Type VI construction, shall be protected by automatic-closing Class B fire doors or fire windows, unless the exterior stairway or ramp is enclosed in one-hour fire-resistive construction.

(d) Except where guarded on the side by the exterior wall of the building, or by an enclosing wall, an exterior stairway or ramp more than three stories or thirty feet above the ground shall be guarded by a railing, balustrade or grille not less than six feet high with openings not more than six inches wide.

SECTION 1812. *Fire Escapes.* — (a) Fire escapes shall not be erected to serve as required exits except as follows: —

(1) From existing buildings five stories or less in height.

(2) From new buildings four stories or less in height and two thousand square feet or less in area.

(3) Where ladders may serve as exits.

(4) As emergency exits from buildings of Group A or Group B occupancy as provided in Parts 3 and 4, and

(5) Where ordered by the commissioner under the provisions of section sixteen of Part 1.

(b) Fire escapes shall be erected outside and shall be secured to the exterior walls of buildings.

(c) Fire escape landings and stairs shall have a clear exit width of not less than twenty-four inches nor, except in the case of emergency exits from buildings of Group A and Group B, less than one inch for every six persons served.

(d) Fire escapes shall be of incombustible materials.

(e) The floors of fire escape balconies or landings shall be of open construction with steel bars not over one half inch nor less than one quarter inch wide and spaces not over one and one quarter inches each nor less in the aggregate than two thirds the floor area. The bars shall be rigidly spaced near their ends and at intervals not exceeding two feet. Floors shall be securely attached to supports.

(f) Fire escape stairs, if steeper than is allowed for interior stairs, shall not be steeper than necessary, nor in any event steeper than sixty degrees with the horizontal. Stairs steeper than sixty degrees shall be deemed ladders and shall not be used for exits except where ladders are allowed. The product of the tread and rise in inches shall be not greater than seventy-seven and the rise shall not exceed nine inches. The construction of the tread shall be as required for landing floors and not less than six inches wide. Treads shall be securely attached to stringers. There shall be not less than three nor more than fifteen risers between landings.

(g) The sides and ends of fire escape landings and the sides of stairs, where not guarded by a wall, shall have a railing at least three feet high, consisting of a bar not less than one and one half by three eighths inch and a balustrade of half-inch round bars or equivalent with a lower rail. The railing shall be supported by posts and shall be sufficient to withstand safely a lateral force of twenty pounds per foot of rail.

(h) Openings for doorways or windows under or within five feet from a fire escape, except in buildings

of Type VI construction, shall be protected by automatic-closing Class B fire doors or fire windows, unless this requirement is waived by the commissioner.

(i) Fire escapes shall not be cantilevered from masonry walls more than five times the thickness of the wall. Bracketed cantilevers shall be bolted through the wall with plate washers set in mortar on the inside.

(j) Except in the webs of structural channels and I-beams, and in the reticular or cross bars of factory-assembled floor gratings approved as flooring for fire escapes, the steel in fire escapes shall not be thinner than one quarter inch nor shall bolts be less than three eighths inch. Stove bolts shall not be used. If stringers of stairs are spliced, the splice shall be made by riveting or welding, and not by bolting.

(k) The lowest run of fire escape stairs may be hinged near the top to swing up into a horizontal position when not in use. Such runs shall be counterbalanced but not so heavily that they will fail to lower by gravity when released. The hinge shall consist of a single round bar, not less than seven eighths inch diameter, with approved bearings on both stringers of the lower run and properly supported. The hinge bar shall be not less than two inches horizontally back from the nosing of the stair tread under which it is placed. The hinged run shall be held in horizontal position by a bent bar at least seven eighths inch in diameter, rigidly held in bearings and bent across the stairway above the hinged run in such manner that a person using the fire escape for egress must release the hinged run before reaching it, or by other approved device.

SECTION 1813. *Ladders as Exits.*—(a) Ladders shall not serve as exits except where specifically allowed in this part and in Parts 3 to 12, inclusive. A ladder not more than one story high may serve as exit where a scuttle is allowed.

(b) Ladders serving as exits shall be permanently fixed in place. In buildings of Type I, Type II and Type V, ladder exits shall be incombustible. Rungs shall be uniformly spaced, not over twelve inches top to top, and shall be supported by two rails not less than twelve inches apart.

(c) Ladder exits shall not be higher than fifteen feet in a single run. Successive runs shall be offset at least two feet with a platform and railing at the bottom of each run above the lowest.

SECTION 1814. *Elevators as Exits.*—(a) Elevators may serve as exits from stories of buildings where all the following requirements are complied with, namely:—

(1) There are two other remote exits from the stories.

(2) The elevators shall be passenger elevators, not less than two in number enclosed in a single shaft or in adjoining shafts. The elevators shall have capacity to evacuate the occupants of any floor in five trips each.

(3) The elevators shall be in operation and in charge of licensed operators during usual business hours and when the building is occupied.

(4) The elevators shall have a lobby outside their enclosure in each story with a floor area of at least two square feet for every occupant in the story, separated from the rest of the story by partitions of

not less than one-hour fire-resistive construction. Vertical openings within such lobbies shall be enclosed in all stories in which they occur.

(5) In buildings of Type III or Type IV construction, the enclosure of lobbies in successive stories shall be continuous, forming a complete one-hour separation as specified in Part 13, through all stories.

(b) Elevators serving as exits shall have sufficient speed to make a round trip from first story to top and back without intermediate stops in two minutes.

SECTION 1815. *Horizontal Exits.* — (a) A horizontal exit shall consist of a doorway in an exterior or party wall of a building or in a fire wall separating two fire divisions of a building, which leads to a story, in another building or fire division, at the same or approximately the same level, from which egress may be made.

(b) A horizontal exit may serve as an exit from a room, from a story or from a building, but not from the interior stairway or ramp required in paragraph (f) of section eighteen hundred and two.

(c) The clear floor area in the story in the building or fire division to which a horizontal exit leads shall be sufficient to contain the occupants of the story in both buildings or fire-divisions allowing three square feet for each person.

(d) A horizontal exit shall have at least the width required for it as an exit, or for the exits which it serves as outlet.

(e) Where the floors connected by a horizontal exit are at different levels a ramp shall be provided the full width of the exit sloping not over one vertical in ten horizontal, with guard railing on the open sides.

(f) The doorway of a horizontal exit in an exterior wall of a building may lead to an adjoining or nearby building by means of a connecting balcony or bridge or by a tunnel, at least as wide as the doorway. The floor of such balcony or bridge, except as provided in paragraph (g) of this section, shall be solid of Type I construction, and shall be level with, or not more than one six-inch step down from, the floors with which it connects. The floor of such a balcony, bridge or tunnel shall be horizontal or have a slope not exceeding one vertical in ten horizontal, and shall not contain steps or stairs except with the approval of the commissioner. Unless the balcony or bridge is enclosed in one-hour fire-resistive incombustible construction, doorways or windows opening on or under, or within five feet from such balcony or bridge, shall have automatic-closing Class B fire doors or fire windows. The open sides of such balcony or bridge shall be guarded as required for the landings of exterior stairways.

(g) Connecting balconies of fire escape construction may be used for horizontal exits only where fire escapes are permitted.

SECTION 1816. *Other Exits.* — Sliding poles, chutes or other devices provided as means of egress shall conform in all respects to such requirements as the commissioner shall in any case prescribe.

SECTION 1817. *Exit Enclosures.* — (a) Interior stairways and ramps shall be enclosed as specified in Parts 3 to 12, inclusive and in Part 15.

(b) Interior stairways and ramps which serve as required exits from stories above the second story

shall be enclosed, except as otherwise provided in Parts 3 to 12, inclusive, in all stories in which they occur.

(c) Doors in a stair enclosure shall be automatic or self-closing and shall never be locked against egress except in detention buildings. Such doors shall swing in the direction of egress and shall not in any position reduce the width of the stairway or its landings below that which is required.

SECTION 1818. *Exit Signs.*—Required exits, except in buildings of Group I, Division 1, shall be marked by suitable signs sufficiently illuminated to be easily read when the building is occupied. If exits are located where they would not be expected to be found, directing signs shall be provided as they may be required by the commissioner.

SECTION 1819. *Exit Maintenance and Lighting.*—  
(a) Required stairways, passageways, corridors and other exits shall be at all times maintained in safe condition, and when the building is occupied, shall be kept clear of obstructions and ready for use.

(b) Outside stairs and fire escapes and the vestibules of smokeproof towers shall be cleared promptly of ice or snow. Awnings shall not be permitted to interfere with fire escapes.

(c) Required stairways, passageways, corridors and other exits, interior or exterior, except in single-family dwellings and within apartments or suites of buildings of Group H and Group I, shall be kept adequately lighted when the building is occupied, or shall be provided with approved means for lighting which can be turned on by an occupant at a convenient point or points.

## PART 19.

## DOORS, WINDOWS AND SKYLIGHTS.

## SECTION

- 1901 — Doors.
- 1902 — Windows.
- 1903 — Skylights.
- 1904 — Sidewalk Lights.

SECTION 1901. *Doors.* — (a) Doors in doorways which serve as required exits shall conform to the requirements of Part 18.

(b) Doorways in enclosures of vertical openings shall have doors which conform to the requirements of Part 15.

(c) Doorways in required separations between two units of occupancy or between two fire divisions of a building shall have doors which conform to the requirements of Part 13.

(d) Except where otherwise specified in this code, doorways in walls required to have one-hour resistance to the spread of fire shall have doors which, if of wood, shall be not less than one and one half inches thick in any part. Such doors, if not of wood, or if larger than twenty-five square feet in area, shall be Class C fire doors.

(e) Except where otherwise specified in this code, doorways in walls required to have two-hour resistance to the spread of fire shall be automatic-closing Class B fire doors.

(f) Except where otherwise specified in this code, doorways and other openings in walls required to have three-hour resistance to the spread of fire shall have automatic-closing Class B fire doors on both sides of the wall. The sum of the areas of such

openings in one story shall not exceed one third the area of the wall and no single opening shall be greater in area than two hundred square feet.

(g) Doorways and other openings in party walls and, except where otherwise specified in this code, in walls required to have four-hour resistance to the spread of fire, shall have automatic-closing Class A fire doors on both sides of the wall. The sum of the areas of such openings in one story shall not exceed one third the area of the wall and no single opening shall be greater in area than one hundred square feet.

(h) In the protection of openings less than two square feet in area in fire-resistive walls, the commissioner may waive in part or modify the requirements of this section subject to such conditions as he shall in each case specify.

(i) In doorways required to have specified width and height a stop moulding or rabbet of the frame may project on each side and at the top not more than three quarters inch inside the required dimensions. The door, in open position, shall clear the required width of the doorway completely and the door and frame shall have additional width if necessary for this purpose.

(j) Doors required to be automatic-closing shall be self-closing and normally closed, or equipped to close automatically by the action of heat in the event of fire.

SECTION 1902. *Windows.* — (a) Fire windows shall conform to the requirements of Part 22.

(b) Windows in exterior walls of buildings shall conform to the requirements of Parts 3 to 12, inclusive, and Parts 14 and 20.

(c) Windows in enclosures of vertical openings shall conform to the requirements of Part 15.

(d) Windows in required separations between two units of occupancy or between two fire divisions of a building shall conform to the requirements of Part 13.

(e) Windows in other walls and partitions required to have resistance to the spread of fire shall be fire windows.

(f) In walls and partitions the openings of which are required to have the protection of fire doors, a fixed fire window may be considered equivalent to one Class B fire door, but two such windows shall not be substituted as equivalent to two doors in an opening where two fire doors are required.

(g) In the exterior walls of buildings of approved occupancy and construction the commissioner may allow the substitution of an approved system of open sprinklers and ordinary windows for the fire windows specified in this section.

(h) Windows in exterior walls of elevator shafts shall be protected by vertical metal bars not less than five eighths inch in diameter, outside the sash, forming spaces not more than ten inches wide, firmly secured in the opening.

(i) Openings in cellar and basement walls shall have effective protection against the passage of rats.

(j) In display windows fronting on a public way, in the first story of a building, a bulkhead may be constructed which shall be of the same type of construction as the first floor. Where the first floor is continuous to the exterior wall without opening, a platform of wood or other combustible material may be built to form the raised floor of the display space.

In display windows, fronting on a public way, not more than two stories high, the back, sides and ceiling of the display space, shelves, partitions and the like, and entrance vestibules and doorways in connection with such display windows, may be of wood or other combustible but not highly flammable material; provided, that this paragraph shall not be construed to allow a vertical opening in any floor without the enclosure specified in Part 15.

(k) Windows with sills less than thirty-two inches above the floor and more than ten feet above the ground shall have protection against a person's falling out.

SECTION 1903. *Skylights.* — (a) Except on greenhouses skylights shall be of incombustible materials.

(b) Except on greenhouses, and except over photographic studios with the approval of the commissioner, skylights shall be glazed with wire glass or shall be protected by wire screens. Such screens shall be of at least No. 12 gage wire with not larger than one-inch mesh, on substantial metal supports, at least six inches but not more than twelve inches above the glass and parallel thereto, and projecting at least six inches beyond the edge of the skylight.

(c) Skylights over stairways and corridors, except in buildings of Group I, and skylights over restaurants, halls and other public rooms, shall be glazed with wire glass or protected by a wire screen or a ceiling light of wire glass below.

(d) Skylights, except the glass thereof, shall be designed to support the loads provided in Part 23 for roofs of corresponding slope.

(e) The parts of skylights exposed to the weather, gutters for leakage or condensation, outside screens and their supports of metal, shall be on non-corrodible metal.

SECTION 1904. *Sidewalk Lights.* — Glass units of approved shape, size and thickness may be set in reinforced concrete roofs, floors or sidewalks, with or without metal shields, in a manner approved by the commissioner. Screen protection shall not be required above or below such construction except where specifically required by the commissioner.

## PART 20.

### PENTHOUSES AND ROOF STRUCTURES.

#### SECTION

- 2001 — Height of Buildings.
- 2002 — Penthouses.
- 2003 — Roof Structures.

SECTION 2001. *Height of Buildings.* — (a) The limitation upon the height of buildings measured to the highest point of the roof thereof specified in Parts 3 to 12, inclusive, and section one hundred and thirty-six of Part 1 of this code shall not be held to limit the height of the steeples of churches, towers, domes, cupolas, belfries, parapets, or other walls, cornices, statuary, balustrades, railings, flag poles, weather-vanes, chimneys, vent pipes, skylights, ventilators, steam exhausts, tanks, signs and penthouses for the enclosure of tanks, stairways, elevator machinery, ventilating fans and the like, erected upon or above the roof of a building, pro-

vided such structures shall not be occupied by persons nor be used for storage or for a manufacturing process requiring constant or frequent attendance.

(b) The provisions of this part shall not be held to authorize construction of any kind above the limit of height specified for every part of a building in section one hundred and thirty-six of Part 1 of this code.

(c) The limitation of height of buildings contained in Parts 3 to 12, inclusive, of this code and the provisions of this part shall not be held to prohibit the use of the open roof of a building, nor the laying of suitable flooring over the roof covering, which conforms with the provisions of this code for the type of construction of the building.

SECTION 2002. *Penthouses.*—(a) Penthouses enclosing elevator machinery, ventilating fans, tanks, elevators, stairways and the like shall not be larger than reasonably necessary for their purpose, including the storage of tools, spare parts, appliances and materials necessary for the maintenance and repair of such equipment.

(b) Penthouses on buildings of Type I or Type II construction shall be of incombustible materials and the walls and roofs thereof shall afford protection against fire outside of one-hour fire-resistive construction. Doors and windows in such walls shall be Class C fire doors or fire windows.

(c) Penthouses on buildings of Type V construction shall be of incombustible materials including the doors and windows thereof.

(d) Penthouses on buildings of Type III, Type IV or Type VI shall be of the same type of construction as the building and the walls thereof may be constructed as provided in this code for partitions, covered on the outside by metal, cement plaster on metal lath or equally fire-retardant covering.

(e) The wall of a penthouse which rests upon the exterior wall of a building shall conform to the requirements of this code for an exterior wall.

(f) Except where used as provided for in paragraph (a) of this section, a penthouse upon the roof of a building shall be considered an additional story or additional stories of the building and shall conform to the requirements therefor. The provisions of this section shall not be held to limit the construction of such additional stories.

**SECTION 2003. *Roof Structures.*** — (a) The walls of dormers shall be constructed as specified in this code either for the exterior walls or for the roof of the building on which they are built.

(b) Where persons occupy or use the open roof of a building, such roof or the portion so occupied shall be guarded by a parapet wall or approved fence or railing not less than forty-two inches high.

(c) Except as otherwise provided in this part, and except flag poles and water tanks, all structures erected on the roof of a building shall be of combustible materials.

## PART 21.

## CHIMNEYS AND HEATING APPARATUS.

## SECTION

- 2101 — Support of Chimneys.
- 2102 — Chimney Construction.
- 2103 — Chimney Height.
- 2104 — Wood near a Chimney.
- 2105 — Smokestacks.
- 2106 — Smoke Pipes.
- 2107 — Fireplaces.
- 2108 — High Pressure Boilers.
- 2109 — Low Pressure Boilers.
- 2110 — Hot Air Furnaces.
- 2111 — Hot Air Pipes and Registers.
- 2112 — Electric Ranges, Water Heaters and Hot Plates.
- 2113 — Domestic Stoves and Ranges.
- 2114 — Commercial Stoves and Ranges.
- 2115 — Oil Burners.
- 2116 — Incinerators.
- 2117 — Support of Heat Producing Apparatus.
- 2118 — Smoke Connection.
- 2119 — Other Heat Producing Apparatus.

SECTION 2101. *Support of Chimneys.* — (a) A chimney shall support no vertical load except its own weight, but this provision shall not apply to masonry bonded to a chimney outside the required thickness thereof, nor shall it be held to forbid a suspended staging for erection or maintenance. An independent or free-standing chimney shall be stable and shall support its weight and resist the force of the wind without exceeding the stresses allowed by this code for the materials of which it is constructed.

(b) Unless corbelled from a masonry wall, a chimney shall be supported upon a foundation of masonry or reinforced concrete conforming to the provisions of Part 29, upon the furnace which it serves, if of

masonry and capable of supporting the chimney, or upon framing of Type I or Type II construction.

(c) No chimney shall be corbelled from a masonry wall more than the thickness of the wall nor from a wall less than twelve inches thick.

**SECTION 2102. *Chimney Construction.*** — (a) The walls of chimneys shall be of brick, stone, cast stone, concrete blocks, structural clay tile or plain or reinforced concrete, with such lining as is specified in this section.

(b) For the purposes of this part the lining of a chimney flue shall mean the material forming the inner surface of the flue, whether the remainder of the chimney wall is (1) integral with the lining, (2) additional thickness of similar material or (3) of different materials. Except as otherwise specified in paragraph (i) of this section, the lining of every flue in a chimney shall be of burned clay or shale brick not less than three and one half inches thick of A or B quality as specified in Part 24, or of refractory material as specified in this section. The lining of every chimney flue more than two hundred and fifty-six square inches in area of cross-section shall be of refractory material from a point not less than twice the inside diameter of the chimney (the larger diameter if rectangular) below the bottom of the smoke pipe entrance, or from the bottom of the flue, to a point not less than six times such inside diameter above the top of the smoke pipe entrance. Refractory material shall consist of burned fire clay flue lining not less than five eighths inch thick, fire brick not less than three and one half inches thick, or radial hollow clay chimney tile,

made of suitable refractory clay capable of withstanding the heat and corrosive effect of flue gases and having a softening point not lower than nineteen hundred degrees Fahrenheit. In such a chimney mounted upon a masonry furnace the required refractory flue lining shall be continuous with the lining of the furnace and shall extend not less than six times the inside diameter of the flue above the top of the furnace.

(c) Burned fire clay flue linings shall be built in as the masonry of the chimney is laid. All joints and spaces between the masonry and lining shall be thoroughly filled with mortar as each course of the masonry is laid. Cracked, broken or otherwise defective flue lining shall not be used in a chimney. Fire brick or radial tile lining shall be laid in fire clay or with narrow beds and joints of mortar. Burned clay or shale brick lining shall be laid in mortar or fire clay. Brick or radial tile lining may be separated from the chimney wall provided the wall outside the lining is not less than eight inches thick, and both wall and lining are independently stable.

(d) Not more than three flues of burned fire clay flue lining may be laid contiguous in a chimney nor shall the aggregate width of such contiguous flues exceed thirty-seven inches without separating masonry withes at least four inches thick bonded to the walls of the chimney. Walls of brick between two flues in a chimney shall be not less than three and one half inches thick.

(e) The masonry wall of a chimney outside the flue lining shall be not less than four inches thick. In chimneys of radial hollow clay chimney tile in

which wall and lining are integral the total wall thickness shall not be less than six inches.

(f) Stone masonry of sawed or dressed stone in courses, well bonded at corners and tied with anchors of non-corrodible metal shall be not less than four inches thick outside the flue lining. Chimney walls of other stone masonry shall be not less than twelve inches thick outside the flue lining.

(g) Concrete block masonry shall not be used in an independent or free-standing chimney nor in chimneys bonded to walls more than three stories in height.

(h) Structural clay load-bearing tile of A grade as specified in Part 24, may be used in the walls of chimneys, or radial hollow clay chimney tile of equivalent quality. Other hollow clay tile shall not be used. Units shall be so laid that the ends of cells are not exposed.

(i) Chimneys of concrete cast in place shall be reinforced for shrinkage and temperature stresses. Concrete integral with the chimney wall shall be considered satisfactory flue lining in such chimneys above a point thirty feet above the smoke entrance, and in flues less than one hundred and forty-four square inches in area in buildings of Group I, Division 1, provided the concrete walls are not less than six inches thick and the concrete is proportioned for a strength of two thousand pounds per square inch as specified in Part 26.

(j) Chimneys shall have a coping at the top for protection of the masonry from the weather.

SECTION 2103. *Chimney Height.*—(a) Chimneys shall be carried to a height sufficient to protect ad-

joining buildings from fire and smoke and unless the roof is covered with incombustible material, shall extend at least thirty inches above the highest point of intersection with the roof.

(b) Chimney flues shall have a well below the entrance of the lowest smoke pipe and shall be provided with a metal cleanout door with built-in frame.

SECTION 2104. *Wood near a Chimney.* — (a) No chimney shall be built nearer than two inches from wooden floor or roof joists or nearer than one inch from wooden studding, furring or other woodwork. The space about a chimney shall be fire-stopped at each floor and ceiling level with incombustible material, unless such space is treated as a vertical opening and is enclosed as provided in Part 15.

(b) In case wooden beams or other woodwork are supported on a masonry wall or pier bonded to a chimney, such woodwork shall not be nearer than four inches from the chimney. For the purposes of this section a chimney shall consist of the flue or flues, the lining, if any, and the walls to the required thickness.

SECTION 2105. *Smokestacks.* — (a) A smokestack shall support no vertical load other than its own weight, but this shall not be held to forbid a suspended staging for erection or maintenance. A smokestack exposed to the force of the wind shall be capable of resisting such force and support its own weight without exceeding the stresses allowed by this code for the materials of which it is constructed.

(b) A smokestack shall be supported by incombustible construction or by the construction support-

ing the furnace which it serves, but in buildings of wooden construction a stack may be stayed laterally by incombustible stays to the wooden construction. A smokestack may be mounted directly upon and supported by the boiler or furnace which it serves if such boiler or furnace is designed and constructed to support safely the weight thereof.

(c) The metal of a circular steel or sheet iron smokestack shall have not less than the following thickness:—

DIAMETER OF STACK.	Thickness.
Not more than 16 inches . . . . .	No. 10 Gage
More than 16, not over 24 inches . . . . .	No. 8 Gage
More than 24, not over 30 inches . . . . .	$\frac{3}{16}$ inch
More than 30, not over 48 inches . . . . .	$\frac{1}{4}$ inch
More than 48, not over 60 inches . . . . .	$\frac{5}{16}$ inch

(d) A smokestack may be mounted on the outside of a building supported by and secured to the exterior wall thereof. If the wall is of combustible materials the stack shall be not less than four inches and not less than one third the stack diameter away and the wall for a width not less than twice the diameter of the stack shall be covered by one quarter inch of asbestos and sheet metal.

(e) A smokestack inside a building shall be protected from contact with goods or persons by a substantial shield of incombustible materials, with provision for ventilating the space between stack and shield. If a smokestack is within a ventilating shaft or other enclosure of a vertical opening, provision shall be made for ventilating the shaft or enclosure at the bottom and above the roof. Such enclosure

shall be of incombustible materials and the stack shall stand clear of the enclosing walls on all sides.

(f) A smokestack shall have at least four inches clearance from combustible material; such material within twelve inches of the stack shall be covered by one quarter inch asbestos and sheet metal or its equivalent and the space about the stack shall be ventilated.

(g) Pertinent provisions for chimneys shall apply also to smokestacks.

SECTION 2106. *Smoke Pipes.* — (a) Smoke pipes of metal shall be not less than number twenty-four gage copper-bearing, black or galvanized sheet iron, except that where gas is used for fuel, sheet copper weighing not less than sixteen ounces per square foot, or other approved material may be used.

(b) Smoke pipes, where they connect with a chimney, shall be tightly fitted in a burned fire clay, cast iron or other substantial thimble built into the masonry, or a smooth-sided opening of brick or other masonry.

(c) Smoke pipes of unprotected metal shall not be nearer than eighteen inches below exposed combustible construction unless the combustible material is protected by an incombustible shield having a width equal to twice the diameter of the pipe, suspended at least three inches below such combustible material and three inches above the pipe and ventilated on both sides. The space between a metal smoke pipe covered with not less than one and one half inches of asbestos or other approved insulation and combustible material above, or between a smoke pipe of unprotected metal and woodwork above protected

by a ceiling of one-hour fire-resistive rating shall be not less than three inches.

(d) Metal smoke pipes shall be at least twelve inches horizontally from combustible material unless protection and clearance are provided as specified in paragraph (c) of this section.

(e) If a masonry flue connects a furnace with a chimney or a stack, it shall be lined and otherwise constructed as specified for a chimney. The roof of such a flue shall be suitably constructed to support its weight.

**SECTION 2107. *Fireplaces.*** — (a) Fireplace walls shall be not less than eight inches thick and if built of stone or hollow units shall be not less than twelve inches thick. The faces of such walls exposed to fire shall be lined with fire brick or other suitable fire-resistive material. When lined with four inches of fire brick such lining may be included in the required minimum thickness. Every fireplace shall be connected to a chimney flue built as specified in section twenty-one hundred and two.

(b) Fireplaces shall have hearths supported by trimmer arches or other approved fire-resistive construction. The arches and hearths shall be not less than twenty inches wide measured from the face of the chimney breast and shall extend not less than twelve inches beyond the fireplace opening on each side. The arches shall be of brick, stone or hollow tile not less than four inches thick, shall spring from the masonry supporting the fireplace and may thrust against the floor frame whether of wood or other material. A flat stone or reinforced concrete slab may be used to support a hearth instead of an

arch if it is properly supported and a suitable fill provided between it and the hearth. Hearths shall be of brick, stone, tile or concrete. Wood centering under a trimmer arch shall be removed after the masonry has thoroughly set. No wood shall be placed within three inches from the jambs or from the top or arch of a fireplace opening.

(c) No heater burning solid or liquid fuel shall be placed in a fireplace which does not conform with the requirements of this section. The provisions of this section shall not be held to prevent construction without flue of a suitable foundation and wall protection, resembling a fireplace, for a gas-burning space heater; but if such construction has a flue, it shall conform in all respects to the provisions of this section for a fireplace.

(d) A fireplace shall not be connected to the same flue with a central heating furnace or an incinerator.

SECTION 2108. *High Pressure Boilers.* — (a) Boilers generating steam at a pressure in excess of fifteen pounds per square inch shall be so located that no combustible material shall be less than two feet from the top or sides or ten feet from the front; and all combustible material less than four feet from the top or sides shall be protected by incombustible construction of at least one-hour fire-resistive rating and shall be well ventilated to prevent the temperature from rising above two hundred and fifty degrees Fahrenheit.

(b) Steel, cast iron or reinforced concrete columns adjacent to such boilers, except columns which support only the boilers, shall not be in direct contact with boiler settings but there shall be an open and

unobstructed space at least four inches wide for ventilation.

SECTION 2109. *Low Pressure Boilers.*—Boilers generating steam at a pressure not over fifteen pounds per square inch, and hot water heaters not including domestic water supply heaters, shall have clearance from wooden partitions, ceiling and other combustible material, the same as specified for hot air furnaces in section twenty-one hundred and ten.

SECTION 2110. *Hot Air Furnaces.*—(a) Hot air furnaces shall be encased in a metal or masonry shield with an air space between shield and fire box. Unless the shield over the top is double with an air space, the top of the furnace shall be covered with approved insulating material one inch thick.

(b) Combustible material placed within seven feet from a hot air furnace at the front or within two feet at the sides or rear shall be protected by sheet metal, or asbestos board, and if such material is within one foot from such furnace at the sides or rear, it shall be protected in the manner required in section twenty-one hundred and six for wood-work near a metal smoke pipe. The distance from the top of a hot air furnace to exposed combustible material above, within two feet laterally from such furnace and four feet in front, shall be not less than eighteen inches unless such woodwork is protected as provided in section twenty-one hundred and six for combustible material above a metal smoke pipe.

(c) The provisions of this section shall not apply to warm air furnaces where the maximum tempera-

ture in the bonnet or plenum chamber is limited to two hundred and fifty degrees Fahrenheit by approved automatic controls.

SECTION 2111. *Hot Air Pipes and Registers.* — (a) Horizontal hot air furnace pipes shall be placed at least six inches below combustible material except that if such material is protected by metal lath and plaster or a loose-fitting metal shield or if the hot air pipe is covered with one half inch of corrugated asbestos insulation, the clear distance may be reduced to three inches for portions of pipes within five feet from the furnace and to one inch for more distant pipes.

(b) Hot air pipes passing through combustible partitions or floors either shall be double sheet metal pipes with at least one half inch air space or be covered with asbestos paper weighing not less than sixteen pounds per one hundred square feet.

(c) No hot air pipes shall be placed in a wooden stud partition or wooden enclosure unless it is at least five feet horizontally from its outlet on the furnace. Hot air pipes in combustible partitions either shall be double with one half inch air space, or the space shall be lined with sheet metal or other incombustible material, or the pipe shall be covered securely with asbestos paper weighing not less than sixteen pounds per one hundred square feet. Hot air pipes in closets shall be not less than one inch away from woodwork or be double pipe with one half inch air space or be covered with asbestos paper weighing not less than sixteen pounds per one hundred square feet.

(d) Every hot air furnace shall have at least one hot air pipe and register without damper, valve or louvres.

(e) Where a register in the floor directly over a furnace is connected by a pipe from the top thereof, such pipe shall be double with not less than one inch ventilated air space and no combustible material shall be within three inches from the inner pipe.

(f) Hot air registers placed in woodwork shall be surrounded with borders of incombustible material which shall prevent the register from coming in contact therewith.

(g) Register boxes for warm air in wooden floors or partitions shall be made of sheet metal, double, with at least one half inch air space or shall be kept at least one half inch from woodwork and covered with asbestos paper weighing not less than sixteen pounds per one hundred square feet.

(h) The provisions of this section shall not apply to hot air pipes and registers from indirect low pressure steam or hot water radiators, nor from warm air furnaces where the maximum temperature in the bonnet or plenum chamber is limited to two hundred and fifty degrees Fahrenheit by approved automatic controls.

**SECTION 2112. *Electric Ranges, Water Heaters and Hot Plates.***—(a) Electric ranges, gas or electric domestic water supply heaters and gas or electric hot plates shall not be nearer than six inches from a combustible wall unless the combustible material in the wall is protected by two inches clearance and sheet metal or its approved equivalent extending at

least nine inches beyond each side and two feet above the apparatus. Wooden ceiling or shelving shall not be less than two feet above such apparatus.

(b) Gas hot plates and electric hot plates, stoves or appliances of more than eighteen hundred watts capacity shall not be placed upon a wooden shelf or counter unless the appliance has a solid metal floor under the burners or heating elements, raised not less than two inches above the shelf, and the shelf is protected with sheet metal; or unless equivalent approved protection is provided.

**SECTION 2113. *Domestic Stoves and Ranges.*** — (a) Stoves and ranges used for heating one room, or for the cooking or laundry of a single family, whether burning solid, liquid or gaseous fuel, shall not be placed within eight inches from a combustible wall unless the combustible material in the wall is protected by three inches clearance and not less than one-hour fire-resistive construction extending at least twelve inches beyond each side and three feet above the stove or range. Wooden ceiling or shelving shall not be less than three feet above such apparatus.

(b) If the ovens and hoods of stoves and ranges for the cooking for a single family, are ventilated by connection to a chimney, smokestack or ventilating duct, such duct shall be of non-corrodible metal not less than number twenty-six gage separated from combustible material by being covered with asbestos paper weighing not less than thirty-two pounds per one hundred square feet, or of material approved as equivalent. Sheet iron or steel shall not be used in a ventilating duct from the oven of a gas stove.

**SECTION 2114. *Commercial Stoves and Ranges.* —**

(a) Stoves and ranges such as are used in kitchens of restaurants, hotels, clubs and similar establishments shall not be placed nearer than twenty-four inches from a combustible wall unless the combustible material in the wall is protected by six inches clearance, not less than one-hour fire-resistive construction and a shield of metal or other approved incombustible material with free circulation of air between it and the wall, extending at least twenty-four inches beyond each side of the range and four feet above the top.

(b) Such stoves and ranges shall be provided with hoods of incombustible material connected by pipe or duct with an independent chimney flue or smoke stack extending above the roof. The hood, if of sheet metal or other similarly thin material, shall be separated from combustible material above by at least nine inches clearance, or by a ceiling of one-hour fire-resistive construction. The connecting pipe or duct shall be separated from combustible material as specified for smoke pipes in section twenty-one hundred and six, with one half the clearances there specified.

**SECTION 2115. *Oil Burners.* —** Oil burners shall be installed in accordance with chapter one hundred and forty-eight of the General Laws and regulations issued thereunder.**SECTION 2116. *Incinerators.* —** (a) All incinerators, except those not exceeding four square feet in grate area, shall be constructed of brick masonry or reinforced concrete. The walls and roof shall be

at least eight inches thick; if the area of the combustion chamber is fifteen square feet or more, the walls and roof shall be at least twelve inches thick.

(b) The combustion chamber above the grate, and both above and below the grate in down-draft incinerators, shall be lined with fire brick laid in mortar or fire clay or with equally fire-resistive material. Fire brick lining may be included in the required wall and roof thickness.

(c) If the smoke flue is used as a refuse chute, it shall be a smooth-lined chimney, vertical and directly over the combustion chamber. Charging hoppers shall be of approved design and construction and shall not project within the flue area. The area of charging opening shall not exceed one third the flue area nor shall the least dimension of the flue be less than three times the vertical dimension of the charging hopper. The top of the chimney shall be covered with a cage or screen of non-corrodible metal of approved design, and having an area not less than twice the flue area.

**SECTION 2117. *Support of Heat Producing Apparatus.*** — (a) Except as otherwise provided in this section, heat producing apparatus whether electrical or by the combustion of solid, liquid or gaseous fuel shall be supported upon a substantial foundation of incombustible and heat-resistive materials laid on the ground, or upon a floor of Type I construction.

(b) Electrical appliances of less than eighteen hundred watts capacity shall not be subject to the requirements of this section.

(c) Domestic stoves and ranges used for heating one room or for the cooking or laundry of one family,

gas or electric water supply heaters, and heaters burning solid or liquid fuel for the domestic hot water supply of one family, may be supported upon floors of Type II or Type V construction with incombustible flooring. Such apparatus may be supported upon a wooden floor or combustible flooring, either;—

(1) Where the apparatus has solid metal construction under the heating elements, fire or burners and ovens, not less than six inches above the floor and, except under gas or electric apparatus, with free circulation of air over the floor; or

(2) Where the floor is protected by sheet metal under and extending at least six inches beyond the sides and rear and at least twelve inches beyond the front of the apparatus and at least four inches of solid brick masonry or concrete under the apparatus; or with equivalent approved protection.

(d) Stoves, ranges and coal or oil burning water supply heaters, for restaurants, hotels, clubs and similar establishments may be supported upon Type II or Type V construction with incombustible flooring, when the apparatus has solid metal construction under the fire, burners or other heating elements and ovens, raised on metal legs not less than four inches above the floor with free circulation of air between. Such apparatus may be supported upon a wooden floor or combustible flooring, either;—

(1) Where the apparatus has solid metal construction under the fire, burners, or other heating elements and ovens, raised on metal legs not less than four inches above the floor with free circulation of air between, and the floor is protected with non-corrodible sheet metal under and extending at least six inches beyond the sides, rear and front of the appa-

ratus and a baffle sheet of one half inch asbestos secured between two sheets of non-corrodible sheet metal under the entire apparatus suspended two inches below the floor thereof; or

(2) Where the floor is protected by non-corrodible sheet metal under and extending at least six inches beyond the sides, rear and front of the apparatus, and hollow construction, under the apparatus, of brick on edge not less than four nor more than twelve inches apart, topped by reinforced concrete not less than three inches thick; or by equivalent approved protection.

(e) Heating apparatus such as down-draft and oil burning furnaces in which the floor of the combustion chamber rests directly upon a reinforced concrete or other structural floor, shall have a heat-resistive foundation, with ventilation and insulation if necessary, to prevent injury to structural metal or other materials in the floor.

(f) Under boilers, furnaces and other heat-producing apparatus supported upon a floor required by the provisions of Part 29 to be waterproofed, shall be installed insulation equivalent to that required for a wooden floor, to protect the waterproofing against damage from heat.

SECTION 2118. *Smoke Connection.* — Every apparatus for the generation of heat by the combustion of fuel shall have suitable connection to an adequate chimney or smokestack except gas appliances exempted by the regulations for gas fitting issued under section one hundred and sixteen of Part 1 of this code and other small apparatus of similarly intermittent use burning oil and generating not over

twenty thousand British thermal units per hour, and except such apparatus in foundries, forge shops and similar establishments as shall be exempted with the approval of the commissioner.

**SECTION 2119. *Other Heat Producing Apparatus.***

— Other heat producing apparatus such as bake ovens, coffee roasting ovens, core ovens, japanning ovens, rendering furnaces, stereotype furnaces, wood-drying kilns, annealing furnaces, charcoal furnaces, galvanizing furnaces, gas producers, smoke houses, forges and the like, shall be supported, and nearby woodwork and other combustible material shall be protected from such apparatus in the manner specified in this chapter for apparatus of similar size, temperature, and character of heat exposure. These and other special or uncommon sources of heat and flame shall be so constructed and protected as to prevent heating any wood or other combustible material used in the construction of floors, ceilings, partitions or other parts of a building, or required waterproofing, to a temperature over two hundred and fifty degrees Fahrenheit, when in full operation, and shall be so constructed as not to be liable to undue corrosion or deterioration or to accidental overturn or other disarrangement conducive to danger.

## PART 22.

## FIRE-RESISTIVE CONSTRUCTION.

## SECTION

- 2201 — Determination of Fire-Resistance.
- 2202 — Fire-Resistive Materials and Construction.
- 2203 — Fire-Protection of Steel Columns.
- 2204 — Fire-Protection of Cast Iron Columns.
- 2205 — Fire-Protection of Steel in Reinforced Concrete Columns.
- 2206 — Fire-Protection of Steel Beams, Girders and Trusses.
- 2207 — Fire-Protection of Steel in Reinforced Concrete Beams.
- 2208 — Fire-Protection of Steel Reinforcing in Floors and Roofs.
- 2209 — Fire-Resistive Floor and Roof Construction.
- 2210 — Fire-Resistive Ceiling Construction.
- 2211 — Fire-Resistive Bearing Walls and Partitions.
- 2212 — Fire-Resistive Non-Bearing Walls and Partitions.
- 2213 — Fire-Resistive Doors.
- 2214 — Fire Door Construction.
- 2215 — Fire-Resistive Shutters.
- 2216 — Fire-Resistive Windows.
- 2217 — Fire-Resistive Roof Covering.

SECTION 2201. *Determination of Fire-Resistance.*

— (a) Materials of construction and fire-protective materials, and assemblies or combinations thereof, shall be classified for fire-protective and fire-resistive purposes in terms of their performance in authoritative tests made in accordance with Standard Specifications for Fire Tests of Building Construction and Materials of the American Society for Testing Materials, hereinafter called the Standard Fire Test.

(b) The materials, assemblies and combinations of materials specified and listed in this chapter shall be assumed to have the fire-resistive rating here given. Other materials, assemblies and combinations shall be given fire-resistive ratings by the commissioner. Such ratings shall be determined by reasonable interpolation among the materials, assemblies and combinations listed and rated in this chapter, and by

authenticated evidence of performance in standard fire tests, with such margin of safety as he shall consider necessary to provide for the exigencies of commercial production and field construction.

**SECTION 2202. *Fire-Resistive Materials and Construction.*** — (a) Materials, to be given the fire-resistive ratings specified in this part, shall have the following minimum qualities:—

(1) Concrete of Class 1 shall be so proportioned, in accordance with Part 26, as to have a strength of at least fifteen hundred pounds per square inch and the coarse aggregate shall consist of limestone, trap rock, blast furnace slag, cinders containing not more than twenty per cent of combustible material, burned clay or shale.

(2) Concrete of Class 2 shall be so proportioned, in accordance with Part 26, as to have a strength of at least fifteen hundred pounds per square inch, the coarse aggregate consisting of sandstone, granite, quartzite, siliceous gravel or other similar material not over one inch in size.

(3) Masonry shall consist of the materials specified in Part 24 laid in lime-cement or cement mortar, or approved masonry cement mortar, except that masonry of gypsum tile shall, and masonry of structural clay tile may, be laid in gypsum mortar. Masonry shall be thoroughly bonded by breaking joints in successive courses or by the use of metal ties.

(4) Brick shall be burned clay or shale, concrete or sand-lime brick of Grade C or better as specified in Part 24.

(5) Stone shall be limestone, marble, slate or

equally fire-resistive natural stone. Sandstone, granite or other stone which, because of its crystalline structure or for other reason, is less fire-resistive, shall not be considered fire-protection for structural metal, but may be used in a masonry wall not less than twelve inches thick required to have fire-resistance. Stone masonry shall have the same fire-resistive rating as brick masonry.

(6) Cast stone shall conform to the requirements of Part 24. Cast stone masonry shall have the same fire-resistive rating as brick masonry.

(7) Concrete blocks, whether solid or hollow, shall have as coarse aggregate limestone, trap rock, blast furnace slag, cinders containing not more than twenty per cent of combustible material, burned clay or shale, and shall otherwise conform to the requirements of Part 24.

(8) Structural clay tile shall conform to the specifications for load-bearing tile, floor tile or partition tile of Part 24. Where partition tile is specified, load-bearing tile may be used.

(9) Gypsum tile, whether solid or hollow, shall conform to Standard Specifications for Gypsum Partition Tile or Block of the American Society for Testing Materials and shall not contain more than three per cent by weight of wood or other combustible binder or filler.

(10) Gypsum concrete shall not contain more than twelve and one half per cent by weight of wood or other combustible binder or filler, and shall have a compressive strength of at least five hundred pounds per square inch as provided in Part 27.

(11) Expanded metal or wire lath as a base or reinforcement for plastering shall weigh not less than

two and two tenths pounds per square yard and shall have not less than two and one half meshes per inch.

(12) Metal mesh reinforcement specified for masonry fire protection of structural metal shall consist of wire lath strips the full thickness of the masonry, laid in the beds thereof, or its approved equivalent.

(13) Metal mesh reinforcement specified for concrete fire protection of structural metal shall consist of wire mesh weighing not less than one and one half pounds per square yard with wire spaced not over four inches, or not less than number eleven gage steel wire spaced not over four inches apart, or its approved equivalent.

(14) Cement plaster shall be proportioned of one part Portland cement, and not more than two parts of sand measured by volume dry and loose to which may be added lime putty or hydrated lime not exceeding fifteen per cent of the cement.

(15) Gypsum plaster, except where otherwise specified, may contain sand not in excess of three times the weight of the gypsum.

(16) Lime plaster shall consist of a mixture of one part lime, not over three parts sand, and water.

(17) Pneumatically projected mortar made of Portland cement, sand and water shall be rated for fire-protection the same as Class 1 concrete.

(18) Concrete fill, where specified in this chapter in connection with hollow masonry units, shall consist of Class 1 or Class 2 concrete poured in the hollow spaces of the units as they are laid.

(b) Portland cement concrete or gypsum concrete poured in place as fire-protection for beams, trusses and other horizontal or inclined members of structural steel and pneumatically projected mortar ap-

plied to structural steel as fire-protection shall be reinforced with metal mesh reinforcement. Concrete protection for vertical columns of structural metal shall have reinforcing consisting of number five wire spaced not over eight inches apart or its equivalent. Reinforcement shall be wrapped around the structural member and so arranged as to be completely embedded in the fire-protective material and to ensure its integrity.

(c) Plaster used as fire-protection or to resist the spread of fire shall be reinforced with metal lath, except plaster less than one inch thick on masonry or concrete.

(d) In the protection of structural metal including reinforcement, one half inch of cement or gypsum plaster may replace an equal thickness of poured concrete or pneumatically projected mortar as protective material; and one inch of cement or gypsum plaster reinforced with metal lath may replace an equal thickness of poured concrete, pneumatically projected mortar or masonry protection.

(e) Where plaster is required without other specification, it shall consist of one half inch of cement or gypsum plaster, except that only gypsum plaster shall be used on gypsum masonry.

(f) In this chapter, except where otherwise specifically stated, the thickness given in a list of materials applies to the next following item only, and not to the total thickness where additional materials are specified.

(g) Pipes, wires, conduits and ducts shall not be embedded in or placed behind the fire-protective materials required for the protection of structural steel or iron except as otherwise provided in this

paragraph. Above fire-protective hung ceilings and within the enclosed spaces, in buildings of Type I and Type II construction, within which, other than the enclosure, fire protection of steel is not required, as specified in Part 16, pipes, wires, conduits and ducts may be placed, provided they are so arranged and so secured that they will not, either by expanding in the event of fire, or otherwise impair the effectiveness of the enclosing protective materials. Electric conduits and wires and gas pipes may be embedded in concrete or masonry fire protection of structural steel where the protective material is reinforced with wire mesh, provided they shall have protective covering at least as thick as required for the steel.

(h) In factories, garages, warehouses and other buildings in which the fire-protective covering required for steel or iron columns may be injured by the movement of vehicles, materials or equipment, the commissioner may require such covering to be protected by metal or other material in a manner satisfactory to him.

(i) Fire-stopping, for the purposes of this chapter, shall mean the stopping-off or enclosure at the ends and wherever else specified of the spaces between studs of partitions, joists of floors and roofs and other similar spaces to prevent drafts of air and the communication of fire from one such space to another. Fire-stopping shall consist of wood not less than one and one half inches thick, of sheet metal not less than twenty-four gage or of masonry, or a combination of such materials. Fire-stopping shall be tightly fitted in the space to be filled, about pipes, wires and ducts and if cut or disturbed in the placement of pipes, wires and ducts shall be repaired.

SECTION 2203. *Fire-Protection of Steel Columns.* —

(a) Structural steel columns required to have fire-protection of a given rating shall be covered on all sides with protective material having not less than the thickness necessary for the required rating. Except where "no fill" is specified, re-entrant and other accessible spaces behind the specified outer protection shall be filled with concrete or brick masonry or the material of the outer protection.

(b) The following materials shall be assumed to afford to steel columns fire-protection of the rating indicated:—

Four-hour rating:—

- (1) Two inches Class 1 concrete.
- (2) Three inches Class 2 concrete, metal mesh reinforcement.
- (3) Three and one half inches brick masonry.
- (4) Two layers two-inch structural clay partition tile masonry, metal mesh in beds.
- (5) Two inches structural clay partition tile masonry, concrete fill, metal mesh in beds, three fourths inch gypsum plaster.
- (6) Four inches structural clay partition tile masonry, concrete fill, metal mesh in beds, five eighths inch lime plaster.
- (7) Four inches structural clay partition tile or concrete block masonry, concrete fill, plaster.
- (8) Three inches hollow gypsum tile masonry, plaster, no fill.
- (9) Two inches gypsum concrete, metal mesh reinforcement.
- (10) Two inches solid gypsum tile masonry, plaster.
- (11) Three inches solid cinder concrete block masonry, plaster.

(12) Four inches hollow cinder concrete block masonry, plaster.

Three-hour rating:—

(1) One and three fourths inches Class 1 concrete.  
(2) Two inches Class 2 concrete, metal mesh reinforcement.

(3) Two inches gypsum concrete.

(4) Two inches solid cinder concrete block masonry, plaster.

(5) Two inches structural clay partition tile masonry, concrete fill.

Two-hour rating:—

(1) One and one half inches Class 1 concrete.  
(2) Two inches Class 2 concrete, metal mesh reinforcement.

(3) One inch Class 1 or Class 2 concrete encased in standard weight steel or wrought iron pipe.

(4) Two inches structural clay partition tile masonry, plaster.

(5) Two layers plaster, each on metal lath, with three fourths inch air space between, two inches total thickness.

(6) One inch gypsum concrete, metal mesh reinforcement.

(7) Two inches solid or three inches hollow gypsum tile masonry, metal mesh in beds, no fill.

One-hour rating:—

(1) One inch Class 1 concrete.  
(2) One and one half inches Class 2 concrete with metal mesh reinforcement.  
(3) Two and one fourth inches brick masonry.  
(4) Two inches structural clay partition tile or concrete block masonry, no fill.  
(5) One inch cement or gypsum plaster on metal lath, no fill.

(c) The thickness of protection on the outer edges of lugs or brackets need not exceed one inch.

**SECTION 2204. *Fire-Protection of Cast Iron Columns.*** — (a) Cast iron columns required to have fire-protection of a given rating shall be covered on all sides with protective materials having not less than the thickness necessary for the required rating. Re-entrant spaces, if any, on the exterior of cast iron columns, and other accessible spaces behind the specified protection, shall be filled with Class 1 concrete or brick masonry or the material of the outer protection.

(b) The following materials shall be assumed to afford to cast iron columns fire-protection of the rating indicated:—

Four-hour rating:—

Cast iron columns shall not be used where protection of four-hour rating is required.

Three-hour rating:—

(1) Two inches Class 1 concrete.

(2) Three inches Class 2 concrete, metal mesh reinforcement.

(3) Two inches structural clay partition tile or concrete block masonry, concrete fill.

(4) One and one half inches cement or gypsum plaster on metal lath and metal furring to form one half inch air space.

Two-hour rating:—

(1) One and one half inches Class 1 concrete.

(2) Two inches Class 2 concrete with metal mesh reinforcement.

One-hour rating:—

(1) One inch Class 1 concrete.

(2) One and one half inches Class 2 concrete with metal mesh reinforcement.

(3) One inch cement or gypsum plaster on metal lath.

**SECTION 2205. *Fire-Protection of Steel in Reinforced Concrete Columns.*** — (a) The main steel reinforcement, including spiral reinforcement and ties larger than one half inch, in reinforced concrete columns required to have fire-protection of a given rating shall be covered with concrete having not less than the thickness listed in this section for the rating indicated: —

Four-hour rating: —

(1) One and one half inches Class 1 concrete.

(2) Two inches Class 2 concrete.

Three-hour rating: —

(1) One and one half inches Class 1 or Class 2 concrete.

Two-hour rating: —

(1) One inch Class 1 concrete.

(2) One and one half inches Class 2 concrete.

One-hour rating: —

(1) One inch Class 1 or Class 2 concrete.

(b) The thickness of protection on column ties not larger than one half inch may be less than that listed by not more than one half inch.

**SECTION 2206. *Fire-Protection of Steel Beams, Girders and Trusses.*** — (a) Steel beams, girders and trusses or the members of trusses, required to have fire-protection of a given rating, shall be covered on all sides except where they are adequately protected

by the floor or roof construction with material having not less than the thickness necessary for the required rating.

(b) The following materials shall be assumed to afford to steel beams, girders and trusses, or the members thereof, fire-protection of the rating indicated:—

Four-hour rating:—

- (1) Two inches Class 1 concrete.
- (2) Three inches Class 2 concrete.
- (3) Three inches structural clay partition tile or concrete block masonry, plaster.
- (4) Three inches hollow gypsum tile masonry, plaster.
- (5) Two inches gypsum concrete.
- (6) Two inches solid gypsum tile masonry, plaster.

Three-hour rating:—

- (1) One and three quarters inches Class 1 concrete.
- (2) Two and one half inches Class 2 concrete.
- (3) One and three quarters inches gypsum concrete.
- (4) Two inches structural clay partition tile, or concrete block masonry, plaster.
- (5) Two inches solid, or three inches hollow gypsum tile masonry.

Two-hour rating:—

- (1) One and one half inches Class 1 Concrete.
- (2) Two inches Class 2 concrete.
- (3) One and one half inches gypsum concrete.

One-hour rating:—

- (1) One inch Class 1 concrete.
- (2) One and one half inches Class 2 concrete.
- (3) Seven eighths inch cement or gypsum plaster on metal lath.

**SECTION 2207. *Fire-Protection of Steel in Reinforced Concrete Beams.*** — (a) The main steel reinforcement, including stirrups larger than one half inch, in reinforced concrete beams, girders and trusses, including the ribs of reinforced concrete ribbed floors or roofs where one or both sides of the ribs, in addition to the soffit, are exposed to fire, required to have fire-protection of a given rating, shall be covered on all sides with concrete having not less than the thickness listed in this section for the required rating. Where a reinforced concrete floor or roof has a flush ceiling formed with approved permanent masonry fillers between ribs, the reinforcement shall have the protection required for reinforcing steel of floors and roofs in section twenty-two hundred and eight.

Four-hour rating:—

- (1) One and one half inches Class 1 concrete.
- (2) Two inches Class 2 concrete.

Three-hour rating:—

- (1) One and one half inches Class 1 or Class 2 concrete.

Two-hour rating:—

- (1) One inch Class 1 concrete.
- (2) One and one half inches Class 2 concrete.

One-hour rating:—

- (1) One inch Class 1 or Class 2 concrete.
- (b) The thickness of protection on stirrups not larger than one half inch may be less than that listed by not more than one half inch.

**SECTION 2208. *Fire-Protection of Steel Reinforcing in Floors and Roofs.*** — (a) The steel reinforcement in reinforced concrete floors and roofs with flush or

plane ceilings, such that the exposure to fire is on the soffit only, required to have fire-protection of a given rating, shall be covered with concrete having not less than the thickness listed in this section for the required rating. In floors or roofs having reinforced concrete ribs where the concrete surrounding the steel reinforcement is exposed to fire on one or both sides in addition to the soffit, such reinforcement shall have the protection specified in section twenty-two hundred and seven for steel in reinforced concrete beams.

Four-hour rating:—

- (1) One inch Class 1 concrete.
- (2) One and one fourth inches Class 2 concrete.

Three-hour rating:—

- (1) One inch Class 1 or Class 2 concrete.

Two-hour rating:—

- (1) Three fourths inch Class 1 concrete. .
- (2) One inch Class 2 concrete.

One-hour rating:—

- (1) Three fourths inch Class 1 or Class 2 concrete.
- (b) Gypsum concrete covering in reinforced gypsum concrete floors and roofs shall have the same thickness for a given rating as Class 1 concrete.

SECTION 2209. *Fire-Resistive Floor and Roof Construction.*—(a) Floors and roofs required to have resistance of a given rating to the spread of fire shall have such thickness of the materials of which it is constructed, as shall be necessary for the required rating, and structural metal forming a part of such floors or roofs shall have protection against fire of such required rating. Floors and roofs required to have two-hour or longer resistance to fire shall be

constructed of incombustible materials. Granolithic, burned clay tile, ceramic tile or other similar incombustible floor finish of a given thickness may be substituted for an equal thickness, and sand, cinder or other incombustible filling material, with or without embedded wooden screeds, may be substituted for two thirds its thickness, of the floor or roof construction material specified in this section; provided, that such floors and roofs shall have adequate thickness for structural purposes.

(b) The following floor or roof construction shall be assumed to afford resistance to the spread of fire of the rating indicated:—

Four-hour rating:—

(1) Four inches solid slab of reinforced concrete or reinforced gypsum concrete.

(2) Four inches solid masonry arches or slabs.

(3) Four inches structural clay floor tile masonry arches or slabs with top covering of not less than two inches of solid masonry or reinforced concrete.

(4) Five inches combination reinforced concrete slab consisting of permanent fillers of concrete block, gypsum or structural clay tile and one and one half inches of concrete topping; but if structural clay partition tiles are used for fillers they shall be plastered on the soffit.

Three-hour rating:—

(1) Three inches solid slab of reinforced concrete or reinforced gypsum concrete.

(2) Three inches solid masonry arches or slabs.

(3) Four inches structural clay floor tile masonry, arches or slabs with top covering of not less than one and one half inches of solid masonry or reinforced concrete.

(4) Four inches combination reinforced concrete slab consisting of permanent fillers of concrete block, gypsum or structural clay tile and one-inch concrete topping; but if structural clay partition tiles are used for fillers, they shall be plastered on the soffit.

Two-hour rating:—

(1) Two and one half inches solid slab of reinforced concrete or reinforced gypsum concrete.

(2) Two and one half inches solid masonry arches or slabs.

(3) Three inches structural clay floor tile masonry, arches or slabs with top covering of not less than one inch of solid masonry or reinforced concrete.

One-hour rating:—

(1) Three inches structural clay floor tile masonry, arches or slabs with all joints thoroughly filled with cement or gypsum mortar.

(2) Wood floor or roof construction with joists not less than one and one half inches in least dimension, fire-stopped, double board floor, approved asbestos felt between layers of boards, and with a ceiling of at least three quarters inch cement or gypsum plaster on metal lath.

(3) Steel beams or steel joists not more than thirty-six inches apart on centers with incombustible floor and a ceiling of at least three fourths inch cement or gypsum plaster on metal lath metal furring.

#### SECTION 2210. *Fire-Resistive Ceiling Construction.*

— (a) Ceilings required to afford fire-protection of a given rating to the floor or roof framing under which it is supported shall be of fire-resistive materials of at least the thickness necessary for the given rating. A fire-resistive ceiling and all hangers and

fastenings necessary for its support to the protected framing shall be of incombustible materials. It shall be capable of sustaining its own weight without exceeding allowable stresses. Metal reinforcement in such a ceiling shall be protected from fire as specified in section twenty-two hundred and eight for reinforcing in a floor.

(b) The following ceiling construction shall be assumed to afford to floor or roof framing fire-protection of the rating indicated:—

Four-hour rating:—

(1) Two and one half inches reinforced Class 1 concrete or reinforced gypsum concrete.

(2) Two inches precast reinforced gypsum concrete, plastered.

Three-hour rating:—

(1) Two inches reinforced Class 1 concrete or reinforced gypsum concrete.

(2) Two inches precast reinforced gypsum concrete, lapped or rabbeted joints.

Two-hour rating:—

(1) One and one half inches reinforced Class 1 concrete or reinforced gypsum concrete.

One-hour rating:—

(1) Three fourths inch cement or gypsum plaster on metal lath.

**SECTION 2211. *Fire-Resistive Bearing Walls and Partitions.***—(a) Bearing walls and partitions required to have resistance to fire or the spread of fire of a given rating shall be constructed of fire-resistive materials and shall have at least the thickness necessary for the required rating. Walls required to have two-hour or longer rating shall be of

incombustible materials. Steel reinforcement in reinforced concrete walls shall have the same protection for the given rating as is required in section twenty-two hundred and eight for steel in floors.

(b) Bearing walls and partitions of the following construction and thickness shall be assumed to have resistance to fire and the spread of fire of the rating indicated:—

Four-hour rating:—

- (1) Eight inches solid brick masonry.
- (2) Twelve inches hollow wall of brick masonry.
- (3) Eight inches hollow wall of brick masonry plastered both sides.
- (4) Twelve inches structural clay load-bearing tile masonry with two units and not less than three cells in the thickness of the wall.
- (5) Eight inches structural clay load-bearing tile masonry with one unit and not less than two cells in the thickness of the wall, plastered both sides.
- (6) Twelve inches concrete block masonry with one unit and not less than two cells in the thickness of the wall.
- (7) Eight inches one-piece concrete block masonry with shells and webs at least one and one half inches thick, plastered both sides.
- (8) Twelve inches total thickness of brick masonry facing bonded to structural clay load-bearing tile masonry backing.
- (9) Eight inches solid concrete.
- (10) Six inches solid reinforced concrete.
- (11) A steel or reinforced concrete frame bearing wall in which the steel has fire-protection of four-hour rating, with panel filling as specified in section twenty-two hundred and twelve for a non-bearing wall of four-hour rating.

Three-hour rating: —

- (1) Eight inches structural clay load-bearing tile masonry with two units and not less than four cells in the thickness of the wall.
- (2) Twelve inches structural clay load-bearing tile masonry with one unit and not less than three cells in the thickness of the wall.
- (3) Eight inches one-piece concrete block masonry with shells and webs not less than one and one half inches thick, plastered both sides.
- (4) Eight inches one-piece concrete block masonry with shells and webs not less than two inches thick.
- (5) Five inches solid reinforced concrete.
- (6) A steel or reinforced concrete frame bearing wall in which the steel has fire-protection of three-hour rating, with panel filling as specified in section twenty-two hundred and twelve for a non-bearing wall of three-hour rating.

Two-hour rating: —

- (1) Eight inches structural clay load-bearing tile masonry with not less than three cells in the thickness of the wall.
- (2) Eight inches concrete block masonry with shells and webs not less than one and one half inches thick.
- (3) A steel or reinforced concrete frame bearing wall in which the steel has fire-protection of two-hour rating, with panel filling as specified in section twenty-two hundred and twelve for a non-bearing wall of two-hour rating.

One-hour rating: —

- (1) A steel or wooden stud bearing wall covered on both sides with one-inch cement or gypsum plaster on metal lath, fire-stopped, if of wood.
- (2) A steel or reinforced concrete frame bearing

wall in which the steel has fire-protection of one-hour rating, with panel filling as specified in section twenty-two hundred and twelve for a non-bearing wall of one-hour rating.

*SECTION 2212. Fire-Resistive Non-Bearing Walls and Partitions.* — (a) Non-bearing walls and partitions required to have resistance to fire and the spread of fire of a given rating shall be constructed of fire-resistive materials and shall have at least the thickness necessary for the required rating. Walls required to have two-hour or longer rating shall be of incombustible materials. Steel reinforcement in reinforced concrete walls shall have the same protection for the given rating as is required in section twenty-two hundred and eight for steel in floors.

(b) Non-bearing walls and partitions of the following construction and thickness shall be assumed to have resistance to fire and the spread of fire of the rating indicated:—

Four-hour rating:—

- (1) Eight inches solid brick masonry.
- (2) Three and one half inches solid brick masonry, plastered both sides.
- (3) Six inches structural clay load-bearing tile, plastered both sides.
- (4) Six inches solid concrete.
- (5) Four inches solid reinforced concrete.
- (6) Any wall which, as a bearing wall, has a three-hour or four-hour rating in section twenty-two hundred and eleven, except the steel or reinforced concrete frame bearing wall.

Three-hour rating:—

- (1) Three and one half inches solid brick masonry.

(2) Four inches structural clay load-bearing tile, plastered both sides.

(3) Four inches solid concrete.

(4) Three inches reinforced concrete.

(5) Any wall which, as a bearing wall, has a two-hour rating in section twenty-two hundred and eleven, except the steel or reinforced concrete frame bearing wall.

Two-hour rating:—

(1) Three inches gypsum tile masonry, plastered both sides.

(2) Eight inches structural clay partition tile masonry, plastered both sides.

(3) Eight inches structural clay load-bearing tile, with three cells in the thickness of the wall.

(4) Four inches concrete block plastered both sides.

(5) Two inches solid neat, fibered, gypsum plaster on metal lath and incombustible studding.

One-hour rating:—

(1) Three inches gypsum tile masonry.

(2) Two inches solid gypsum tile masonry plastered both sides.

(3) Three inches structural clay partition tile plastered both sides.

(4) Two and one half inches solid cement or sanded gypsum plaster on metal lath and incombustible studding.

(5) Three inches total thickness of hollow wall, three fourths inch cement or gypsum plaster on metal lath and incombustible studding.

(6) Three inches total thickness of hollow wall, three fourths inch cement or gypsum plaster on metal lath and wooden studding, fire-stopped.

SECTION 2213. *Fire-Resistive Doors.* — (a) Doors which are required to be fire doors, fire-resistive doors, or of fire-resistive construction shall conform to the requirements of this section and section twenty-two hundred and fourteen.

(b) Fire doors shall be classified for the purposes of this code as Class A, Class B, and Class C.

(c) Class A fire doors shall be doors of the following construction as specified in Section twenty-two hundred and fourteen.

(1) Tin-clad, three-ply wood core, sliding.

(2) Tin-clad, three-ply wood core, swinging single leaf, doorway not over six feet wide.

(3) Tin-clad, three-ply wood core, swinging in pairs, doorway not over ten feet wide.

(4) Hollow metal, swinging single leaf, doorway not over four feet wide.

(5) Hollow metal, swinging in pairs, doorway not over eight feet wide.

(6) Sheet metal, sliding, single, doorway not over ten feet wide.

(7) Sheet metal, sliding in pairs, doorway not over twelve feet wide.

(8) Sheet metal, swinging single leaf, doorway not over six feet wide.

(9) Sheet metal, swinging in pairs, doorway not over ten feet wide.

(10) Steel rolling, doorway not over twelve feet wide.

(11) Steel plate, doorway not over four feet wide.

(12) Any other construction equal or superior to a tin-clad three-ply wood core door in a standard fire test, for resistance to fire, the spread of fire and smoke, and transmission of heat.

(d) Class B fire doors shall be doors of the following construction as specified in section twenty-two hundred and fourteen.

- (1) Tin-clad, three-ply wood core.
- (2) Tin-clad, two-ply wood core, sliding, doorway not over ten feet wide.
- (3) Tin-clad, two-ply wood core, swinging single leaf, doorway not over six feet wide.
- (4) Tin-clad, two-ply wood core, swinging in pairs, doorway not over ten feet wide.
- (5) Hollow metal, sliding, doorway not over eight feet wide.
- (6) Metal-clad, paneled, swinging single leaf, doorway not over three feet wide.
- (7) Metal-clad, paneled, swinging in pairs, doorway not over six feet wide.
- (8) Any other construction equal or superior to a tin-clad two-ply wood core door in a standard fire test, for resistance to fire, the spread of fire and smoke, and transmission of heat.

(e) Class C fire doors shall be doors of the following construction as specified in section twenty-two hundred and fourteen.

- (1) Metal-clad, paneled, swinging single leaf, doorway not over four feet wide.
- (2) Metal-clad, paneled, swinging in pairs, doorway not over eight feet wide.

(f) A Class A door may be used where Class B or Class C is specified; a Class B door may be used where Class C is specified. Two Class B or Class C doors on opposite sides of the wall may be used where a single Class A or Class B door is specified.

(g) Fire-resistive doors, when closed, shall completely cover the doorways in the walls and parti-

tions or the openings in the floors or roofs to which they are fitted. A swinging fire door shall either overlap both jambs and the head of the opening not less than four inches or be fitted to a fire-resistive frame with a rabbet the full thickness of the door and with not less than one half inch overlap on the door. A sliding fire door, except in enclosures about passenger elevators, shall overlap both jambs and the head of the opening not less than four inches. A sliding fire door in an enclosure about a passenger elevator shall overlap jambs, head and adjoining panels not less than one half inch. Fire doors shall fit closely at the floor with clearance of not over one quarter inch.

(h) In buildings with combustible floors, doorways required to have fire doors shall have incombustible thresholds the full thickness of the wall, extending at least four inches from the face of the wall where a door is hung and extending laterally at least six inches beyond each jamb of the doorway. Thresholds may be flush with the floor.

(i) The rabbeted frame of a swinging fire door shall be constructed of structural steel built into the concrete, masonry or other fire-resistive material of the wall about the opening and secured thereto, except that the rabbeted frame of a Class B or Class C door may be of wood, covered with sheet metal not less than twenty-six gage in thickness, secured to the wall in the opening.

(j) Fire doors when closed shall fit tightly against the wall or frame so as to provide an effective stop for fire and smoke. Except for the metal-covered wooden frame specified in this section, combustible material shall not intervene between the door and

the fire-resistive material of the wall, floor or roof to which it is fitted.

(k) Hardware for fire doors shall be of malleable iron or rolled structural steel not less than one fourth inch thick except that tubular steel track for sliding doors may be not less than one eighth inch thick. Fire doors shall not depend upon cords, cables or chains to support them in closed position, except in elevator shafts.

(l) Tracks for sliding fire doors shall be so supported that a track hanger comes at each door hanger when the door is closed. Track hangers shall be secured to wood stud walls by screws or bolts, to steel stud walls by bolts or rivets, to masonry walls by through bolts and to concrete walls by through bolts or approved built-in inserts. Expansion shields shall not be used to support fire doors.

(m) Hinges for swinging fire doors, except in wooden stud walls, shall be riveted or through-bolted to the structural steel frame of the opening, through-bolted to the wall if of masonry or concrete or secured by approved inserts in the concrete or built into masonry in approved manner.

(n) Strap hinges and sliding door hangers shall be secured to fire doors by through-bolting, riveting or welding. Swinging fire doors in rabbeted frames, except tin-clad, wood core doors, may be hung on butts. Other swinging fire doors shall have long strap hinges.

(o) Sliding fire doors shall have adequate stops for the closed position. Swinging Class A fire doors shall have surface latches or unit locks. Class B and Class C doors shall have surface latches, unit or mortise locks. The latch bolts of unit or mortise

locks on fire doors shall have a throw of three fourths inch. When mounted in pairs fire doors shall be rabbeted by means of an astragal or otherwise where they come together. One of a pair of swinging fire doors shall have push bolts at top and bottom with a throw of three fourths inch and the other shall be held by latch to the first.

(p) Except in detention buildings, fire doors hung in required exits shall be so fitted with hardware that they can be opened from inside without use of a key when the building is occupied.

SECTION 2214. *Fire Door Construction.* — (a) In the construction of fire doors solder shall not be used, except for filling joints. Sheet metal shall be fastened to wood by nailing and to metal frame by bolting, riveting or welding.

(b) Class A doors shall not have glass panels. Class B doors may have glass panels not larger than one hundred square inches in exposed area nor more than twelve inches in width or height. Class C doors may have glass panels not larger than twelve hundred and ninety-six square inches in exposed area. Glass in fire doors shall be wire glass not less than one quarter inch thick and shall be set five eighths inch in grooves three quarters inch deep.

(c) Fire doors shall be constructed as follows: —

(1) Tin-clad, three-ply wood core doors shall be constructed in accordance with the specifications of the National Board of Fire Underwriters for such doors in Class A openings, and shall bear the label of the Underwriters Laboratories to this effect.

(2) Tin-clad, two-ply wood core doors shall be constructed in accordance with the specifications of the National Board of Fire Underwriters for such

doors in Class B openings and shall bear the label of the Underwriters Laboratories to this effect.

(3) Hollow metal doors shall have substantial stiles and rails of heavy pressed steel, reinforced for hinges and other hardware. Panels shall be of sheet steel filled with asbestos board or other approved insulating materials. The door shall be assembled by welding or riveting. The design and the manufacturer shall be approved by the commissioner.

(4) Sheet metal doors shall be constructed with a rolled steel rigid frame covered both sides with one sixteenth inch asbestos board and twenty-six gage corrugated sheet metal, with corrugations vertical on one side and horizontal on the other, bound on the edges with rolled steel or pressed steel shapes. The design and the manufacturer shall be approved by the commissioner.

(5) A steel rolling fire door shall be constructed of sheet steel interlocking slats, sliding in grooves, counterweighted by springs, the roller and mechanism enclosed in heavy sheet metal. The design and the manufacturer shall be approved by the commissioner.

(6) A steel plate fire door shall be constructed of not less than twelve gage steel plate mounted on a rolled steel frame, assembled by welding or riveting. The design shall be approved by the commissioner.

(7) A metal clad, paneled fire door shall have a wood core with stiles and rails not less than one and three fourths inches thick covered with twenty-six gage sheet steel; panels three fourths inch thick covered with twenty-six gage sheet steel, set three fourths inch in grooves; joints of metal lapped and well nailed.

(d) A door properly bearing the Underwriters'

Label certifying that it is suitable for the protection of a Class A opening shall be acceptable as a Class A door.

(e) A door properly bearing the Underwriters' Label certifying that it is suitable for the protection of a Class B opening shall be acceptable as a Class B door, except that metal clad doors wider than three feet shall not be accepted as Class B doors.

(f) A door properly bearing the Underwriters' Label certifying that it is suitable for the protection of a Class C opening shall be acceptable as a Class C door.

SECTION 2215. *Fire-Resistive Shutters.* — Shutters required to be fire shutters or fire-resistive shutters shall be constructed and hung as specified for Class B fire-resistive doors in sections twenty-two hundred and thirteen and twenty-two hundred and fourteen.

SECTION 2216. *Fire-Resistive Windows.* — (a) Windows which are required to be fire windows, fire-resistive windows, or of fire-resistive construction shall conform to the requirements of this section.

(b) Fire-resistive windows may be fixed or arranged to open and close. Fixed fire-resistive windows shall be so secured in the walls in which they are placed that they may expand in case of fire without buckling. Movable fire-resistive windows shall be opened or closed in one of the following manners: —

(1) One or more sashes may slide horizontally in a fire-resistive frame.

(2) One or more sashes may slide vertically with counterweights or with two sashes counterbalanced

and hung on chains. If a sash is closed in raised position it shall have a fastening.

(3) A sash may be hinged at top, bottom, or either side.

(4) A sash may be pivoted at top and bottom or at the sides.

(5) A sash may be arranged to open and close in any other approved manner, with approved hardware.

(c) Movable sashes in fire-resistive windows shall be fitted to fire-resistive frames of the same or similar construction. Both sashes and frames, and metal mullions between window units, shall be so fitted in the walls in which they are placed as to be continuous with the fire-resistive material of the wall and so secured that they may expand in case of fire without buckling.

(d) Glass in fire-resistive windows shall be wire glass not less than one fourth inch thick and the area of a single light shall not exceed seven hundred and twenty square inches. Glass shall be set three eighths inch in grooves at least one half inch deep. Glass shall be secured by glazing angles or moldings bolted to the sash and forming continuous grooves for the glass.

(e) Fire-resistive windows shall be of the following construction: —

(1) Hollow sheet metal sashes and frames fabricated by pressing, welding, riveting or crimping without the use of solder or other fusible alloy, except for filling joints, and bearing the label of the Underwriters' Laboratories.

(2) Rolled steel or pressed steel sashes fabricated by pressing, welding, riveting or crimping, of a make and style approved by the commissioner.

(3) Any other approved constructions as fire-resistive as that specified in paragraph (1).

(f) Fixed fire-resistive windows of hollow sheet metal construction shall not exceed seven feet in width nor ten feet in height. Fire-resistive windows of hollow sheet metal construction with movable sashes shall not exceed six feet in width nor ten feet in height.

(g) Fire-resistive windows of rolled steel construction shall not exceed eighty-four square feet in area nor twelve feet in either height or width.

(h) Fire-resistive windows and their fastenings shall be capable of resisting the wind pressure on the wall of the building applied either on the inside or the outside of the window without exceeding allowable stresses.

(i) Where fire-resistive windows are required, wooden windows and plain glass may be substituted provided the openings are protected by fire-resistive doors or shutters, or, in buildings of approved occupancy and construction, by an approved system of open sprinklers.

**SECTION 2217. *Fire-Resistive Roof Covering.* —**

(a) Roof covering allowed under this code shall be classified as fire-retardant or ordinary, according to their resistance to fire outside, as provided in this section. Fire-retardant roof covering is the more fire-resistive and may be used on any building. Ordinary roof covering shall not be used where fire-retardant roofing is specified. Roof covering less fire-resistive than ordinary roof covering shall not be used on any building.

(b) Fire-retardant roofing shall be any roof covering which meets the requirements of Class A or

Class B roofing under the specifications of the Underwriters' Laboratories, Inc. The following roof covering shall be assumed to meet the requirements for fire-retardant roofing:—

- (1) Built up roofing consisting of successive layers of roofing felt impregnated with asphalt; a final layer of asphalt in which, while molten, is embedded a continuous layer of roofing gravel or slag.
- (2) Built up roofing consisting of successive layers of roofing felt impregnated with coal tar; a final layer of tar in which, while molten, is embedded a continuous layer of roofing gravel or slag.
- (3) Built up roofing consisting of successive layers of roofing felt impregnated with asphalt; a final layer of asbestos roofing felt impregnated with asphalt weighing not less than fourteen pounds per hundred square feet, or a final layer of asphalt-saturated prepared roofing coated with granulated slate or other similar material.
- (4) Built up roofing consisting of successive layers of roofing felt impregnated with tar or asphalt and a finish of burned clay floor tile, stone flagging, cement concrete or other similar material.
- (5) Sheet metal with locked and soldered joints not less than number twenty-six gage in thickness.
- (6) Shingles of natural slate.
- (7) Shingles of burned clay tile.
- (8) Shingles of sheet metal not less than number twenty-six gage in thickness.
- (9) Shingles of asbestos board not less than one eighth inch thick.
- (10) Shingles of asphalt-saturated felt surfaced with granulated slate or other similar material and weighing not less than one hundred and ninety

pounds per one hundred square feet of roof covered.

(11) Corrugated sheet metal with lapped joints not less than number twenty-six gage in thickness.

(12) Corrugated asbestos board not less than three sixteenths inch thick.

(c) Ordinary roofing shall be any roof covering which meets the requirements of Class C roofing under the specifications of the Underwriters' Laboratories, Inc. The following roof covering shall be assumed to meet the requirements for ordinary roofing:—

(1) Built up roofing consisting of successive layers of roofing felt impregnated with asphalt, coal tar or other approved material, not equal in fire-resistance to a fire-retardant roofing.

(2) Prepared roofing consisting of felt or fabric impregnated or coated, or both, with asphalt, tar or other approved material or shingles of such prepared roofing, not equal in fire-resistance to fire-retardant roofing.

(3) Canvas stretched tightly and coated with paint.

(d) Built up roofing shall be secured to the roof deck by laying the first layer in molten asphalt or tar mopped on the roof deck, or by nailing a layer of building paper to the roof deck over which the roofing felt is laid in molten asphalt or tar. Unless so secured, prepared roofings and shingles, slates, tile, and other roofing, except roof covering weighing not less than fifteen pounds per square foot on a flat roof, shall be well secured to the deck by nailing, bolting, wire or other approved method.

## PART 23.

## LIVE AND DEAD LOADS.

## SECTION

- 2301 — Design for Loads.
- 2302 — Dead and Live Loads.
- 2303 — Weights of Materials.
- 2304 — Loads from Partitions.
- 2305 — Live Loads on Floors.
- 2306 — Special Concentrations.
- 2307 — Partial Loadings.
- 2308 — Impact.
- 2309 — Lateral and Uplift Forces.
- 2310 — Reduction of Live Loads.
- 2311 — Roof Loads.
- 2312 — Wind Loads.
- 2313 — Load Tests of Structure.

SECTION 2301. *Design for Loads.* — All buildings and parts thereof shall be designed to support the loads and withstand the forces to which they are subject, both dead and live, without exceeding stresses allowed for the various materials elsewhere in this code.

SECTION 2302. *Dead and Live Loads.* — (a) The dead loads of a building include all the forces due to weight of the walls, permanent partitions, floors, roofs, framing, and all other permanent stationary construction entering into and becoming part of the building.

(b) The live loads include all loads other than the dead loads.

SECTION 2303. *Weights of Materials.* — (a) The actual weights of the elements of construction and of materials to be supported shall be used in calcu-

lation of the loads. The materials listed in the following table shall be assumed to weigh not less than there indicated:—

	Pounds per Cubic Feet.
Brick (face, sandlime, concrete) masonry . . . . .	140
Brick (common) masonry . . . . .	120
Cast iron . . . . .	450
Cast stone masonry . . . . .	144
Cinders, dry, in bulk . . . . .	45
Cinder fill . . . . .	54
Sand-cinder concrete, fill . . . . .	96
Sand-cinder concrete, structural . . . . .	108
Stone or gravel concrete, plain . . . . .	144
Stone or gravel concrete, reinforced . . . . .	150
Common earth, dry and packed . . . . .	100
Wet mud . . . . .	120
Granite masonry . . . . .	170
Limestone masonry . . . . .	160
Marble masonry . . . . .	160
Sandstone masonry . . . . .	145
Steel . . . . .	490
Timber . . . . .	40
Water . . . . .	62.5

SECTION 2304. *Loads from Partitions.*—(a) In buildings in which permanent partitions occur their weight shall be counted as affecting the design of all supporting structural members, including columns and foundations, as part of the dead load; and in those portions of office buildings in which the prescribed live load does not exceed fifty pounds per square foot, allowance for partition weight shall always be made, whether or not partitions are shown on plans.

(b) If a lay-out of partitions is included in the building plans, the weights of the partitions and their locations shall be determined in accordance therewith, or such lay-out shall be used to determine an equivalent load per square foot of floor to be applied uniformly as a superimposed dead load for purposes of design. But the allowance for partition weight in portions of buildings given to office occupancy, when expressed in pounds per square foot of floor, shall in no case be less than a minimum of two pounds for each foot of clear story height.

(c) In estimating loading from actual weights of partitions it may be assumed that the partition occupies a space one foot wide, and a deduction may be made of the live load displaced on this width.

(d) Arch action of partitions shall not be assumed to relieve the supporting members.

**SECTION 2305. *Live Loads on Floors.*** — The live loads assumed on floors for purposes of design shall be the greatest loads that will probably be produced by the intended occupancies, but the following distributed live loads in pounds per square foot shall be taken as the minimum for the occupancies named, and for similar occupancies not listed which create or accommodate corresponding loadings.

Pounds per  
Square Foot.

<i>Domestic Occupancy:</i> all parts of private dwellings, rooms and suites in apartment houses, lodging houses and clubs; private and ward rooms or dormitory rooms in hospitals, asylums, educational and religious institutions, including corridors giving access thereto; and bedrooms of hotels . . . . .	40
<i>Office Buildings:</i> first and basement floors . . . . .	100

Pounds per  
Square Foot.

<i>Office Occupancy:</i> <sup>1</sup> above first floor in office buildings, offices in other buildings, including corridors . . . . .	50
<i>Church Auditoriums:</i> with fixed seats, including aisles, sanctuary or chancel, sacristies, choirs and chapels . . . . .	60
<i>Class Rooms:</i> in schools and colleges, not exceeding nine hundred square feet in area, or of whatever size if with fixed seats; and school laboratories . . . . .	50
<i>Theatre Auditoriums and Assembly Halls:</i> <sup>1</sup> with fixed seats, including aisles and passageways . . . . .	75
<i>Theatre Stages:</i> gridirons and fly galleries . . . . .	100
<i>Public Occupancy:</i> lobbies, foyers, vestibules and similar public spaces of hotels, theatres, churches, clubs and public buildings; assembly halls, including class and lecture rooms exceeding nine hundred square feet in area, without fixed seats; dance halls, public dining rooms and restaurants, public rooms for social purposes, skating rinks, gymnasiums, grand stands, and all spaces where crowds of people are likely to assemble . . . . .	100
<i>Corridors:</i>	
In theatres and serving assembly halls . . . . .	100
In school buildings . . . . .	75
Other corridors, — same loading as heaviest occupancy to which they provide access.	
<i>Fire Escapes and Exterior Balconies:</i>	
In theatres and serving assembly halls . . . . .	100
In other buildings . . . . .	75
<i>Stairs:</i> <sup>1</sup> same loading as heaviest occupancy to which they give access, but maximum required . . . . .	100
<i>Stores:</i>	
For light merchandise, first and basement floors . . . . .	100
For light merchandise, above first floor, including mezzanine . . . . .	75
For heavy merchandise, all floors . . . . .	125
<i>Storage:</i>	
Light storage . . . . .	125
Heavy storage . . . . .	250

<sup>1</sup> For special floor concentrations and lateral thrusts on stair and balcony rails, see sections 2306 and 2309.

	Pounds per Square Foot.
<i>Manufacturing:</i>	
Heavy manufacturing . . . . .	250
Intermediate manufacturing . . . . .	150
Light manufacturing . . . . .	75
<i>Locker Rooms</i> . . . . .	75
<i>Stables</i> . . . . .	75
<i>Garages:</i> <sup>1</sup> including Apparatus Rooms of Fire Stations:	
Class A — Floors used for vehicles exceeding twenty thousand pounds in weight, including load; and first or street floors of public garages except those limited to passenger vehicles exclusively . . . . .	250
Class B — Floors other than the first of public and first floors of private garages used for vehicles not exceeding twenty thousand pounds in weight, including load; and first or street floors of public garages limited to passenger vehicles exclusively . . . . .	150
Class C — Floors other than the first of garages limited to passenger vehicles not exceeding six thousand pounds in weight; and first floors of private garages limited to not more than six passenger vehicles not exceeding seventy-five hundred pounds each in weight	100
In this section private garages are those limited to the vehicles of a single owner, and all others are public garages.	
A floor directly connecting with a street or driveway by a straight ramp not more than eight feet high shall be regarded as a first or street floor.	
<i>Hangars</i> . . . . .	150
<i>Sidewalks</i> <sup>1</sup> . . . . .	250
<i>Driveways</i> <sup>1</sup> . . . . .	250
<i>Ceilings</i> <sup>1</sup> . . . . .	—

SECTION 2306. *Special Concentrations.* — In the design of floors, consideration shall be given to the effects of known or probable concentrations of load to which they may be subjected; and in buildings

<sup>1</sup> For special floor concentrations and lateral thrusts on stair and balcony rails, see sections 2306 and 2309.

designed for the occupancies listed herein, floors shall be made capable of carrying the prescribed distributed loads or the following minimum concentrations, whichever may result in the greater stresses. The concentrations indicated shall be assumed to occupy spaces two and one half feet square, and so placed as to produce maximum stresses in the members affected.

(1) For office floors, including corridors, a load of two thousand pounds.

(2) For portions of garages subject to Class A loading, a concentrated load of twenty thousand pounds, and to Class B loading, ten thousand pounds.

(3) For sidewalks, a concentrated load of eight thousand pounds.

(4) For driveways, and for trucking spaces within the limits of a structure a concentrated load of twenty thousand pounds.

(5) For structural supports of ceilings under accessible spaces, for trap doors and skylights a concentrated load of two hundred pounds.

SECTION 2307. *Partial Loadings.* — Consideration shall be given to the effects of partial as well as full live loading.

SECTION 2308. *Impact.* — The live loads prescribed herein may be assumed to include a sufficient allowance to cover the effects of ordinary impact. For special occupancies and loadings involving unusual impacts, such as those resulting from moving machinery, elevators, craneways, and the like, provision shall be made by suitably increasing the assumed live loading.

SECTION 2309. *Lateral and Uplift Forces.* — (a) In the design of basement walls and similar approximately vertical structures below grade, the forces due to lateral pressure of adjacent soil shall be calculated. Due allowance shall be made for possible surcharge from fixed or moving loads. When a portion or the whole of the adjacent soil is below a free water surface, calculations shall be based on the weight of the soil as diminished by buoyancy, plus full hydrostatic pressure.

(b) In the design of basement floors and similar approximately horizontal structures below grade, the upward pressure of water, if any, in the supporting soil shall be taken as the full hydrostatic pressure applied over the entire area.

(c) Balcony and stairway railings, exterior and interior, shall be designed to resist a horizontal thrust of twenty pounds per linear foot applied at the top of the rail.

SECTION 2310. *Reduction of Live Loads.* — A reduction of the total live load to be assumed as affecting structural members supporting considerable tributary floor area, or supporting multiple floors, and also of the live load supported by flat and two-way reinforced concrete slabs, shall be permitted according to the following schedule. In this section the term "area tributary" to a supporting member means the load supported by the member, divided by the average load per square foot, and the reductions indicated are applicable to beams, girders, trusses, columns, piers, hangers, walls, and foundations. The "tributary area" for a flat or two-way slab is the area of a panel. No reductions shall be

allowed in the roof load as given in section twenty-three hundred and eleven, on any portion of a structure nor in the special concentrations specified in section twenty-three hundred and six.

*Per Cent Live Load Reductions.*

OCCUPANCIES FOR WHICH PREScribed LIVE LOAD PER SQUARE FOOT IS —	IN MEMBERS SUP- PORTING TRIBUTARY AREAS OF MORE THAN —			IN MEMBERS SUPPORTING STORIES TO NUMBER OF —				
	100 sq. ft.	200 sq. ft.	300 sq. ft.	2.	3.	4.	5.	6 or more.
125 pounds or less . . . .	5	10	15	15	20	30	40	50
Over 125 pounds (except garages) .	0	0	0	5	10	15	20	20
Garages, all classes . . . .	0	0	25	25	25	25	25	25
Two-way and flat slabs, all occupan- cies.	5	10	15	-	-	-	-	-

SECTION 2311. *Roof Loads.* — (a) Flat roofs, and roofs having a rise of four inches or less per foot of run shall be designed to support a vertical live load of thirty pounds per square foot of horizontal projection. Roofs used as roof gardens, or for other such purposes shall be designed as floors to support the loads prescribed for corresponding occupancies.

(b) Roofs having a rise of more than four and less than twelve inches per foot of run shall be designed for a vertical live load of fifteen pounds per square foot of horizontal projection, applied to the entire roof or to either of the sloping surfaces, whichever produces the greater stress, and a wind load as prescribed in section twenty-three hundred and twelve.

(c) Roofs having a rise of twelve inches or more per foot of run shall be designed for wind load only, without other live load.

SECTION 2312. *Wind Loads.*—(a) All buildings shall be made capable of resisting horizontal wind pressures on their exposed vertical surfaces, and wind pressures normal to their sloping roofs without exceeding the stresses allowed in this act.

(b) The overturning moment due to wind pressure shall not exceed two thirds of the moment of stability (as measured by the moment of the dead loads, about the leeward edge of the foundation or critical section at any other level) unless the structure is anchored to resist the excess overturning moment without exceeding the stresses prescribed.

(c) The wind pressure on vertical plane surfaces shall be taken at ten pounds per square foot for those portions less than forty feet above the ground, at fifteen pounds per square foot for portions between forty and eighty feet above the ground and at twenty pounds per square foot for portions more than eighty feet above the ground.

(d) For cylindrical surfaces the area exposed to wind shall be assumed as two thirds of the projected area.

(e) On roofs having a rise of more than four inches per foot of run the wind pressure normal to the surface shall be taken as one and one half pounds per square foot for each inch of rise on one foot run, with a maximum pressure of twenty pounds per square foot when the rise exceeds twelve inches per foot.

SECTION 2313. *Load Tests of Structure.*—(a) The commissioner shall have the right to order the test under load of any portion of a completed structure when the conditions have been such as to leave rea-

sonable doubt as to the adequacy of the structure to serve the purpose for which it was intended. Such tests shall not be required to be made on any concrete or masonry construction until it is at least sixty days old.

(b) In such tests, the member or portion of the structure under test shall be subjected to a total load, including its own weight, which shall equal the total dead load plus twice the live load for which it is required to be designed. This load shall be left in position for a period of twenty-four hours before removal. The structure, if a floor or roof or portion thereof, shall be considered to have passed the test if within twenty-four hours after the removal of the load such floor or roof recovers three quarters of the maximum deflection under the test load. If the member or portion of the structure shows evident failure or fails to meet the recovery requirement, such changes or modifications as are necessary to make the structure adequate for the rated capacity shall be made or, where lawful, and where the structure is undamaged, a lower rating may be established.

## PART 24.

## MASONRY.

## SECTION

- 2401 — Design of Masonry.
- 2402 — Materials of Masonry.
- 2403 — Brick.
- 2404 — Stone.
- 2405 — Cast Stone.
- 2406 — Concrete Blocks.
- 2407 — Structural Clay Tile.
- 2408 — Gypsum Tile.
- 2409 — Plain Concrete.
- 2410 — Plain Gypsum Concrete.
- 2411 — Mortar.
- 2412 — Bond in Masonry.
- 2413 — Allowable Unit Stresses in Masonry.
- 2414 — Masonry Arches.
- 2415 — Reinforced Masonry.
- 2416 — Second-Hand Materials for Masonry.

SECTION 2401. *Design of Masonry.* — Masonry shall be designed by a method admitting of rational analysis according to established principles of mechanics, supplemented by the assumptions herein specified, to support the loads and withstand the forces to which it is subject without exceeding the stresses allowed in this chapter for the various materials thereof.

SECTION 2402. *Materials of Masonry.* — (a) The quality of materials assembled in masonry and the method and manner of their assembly shall be suitable for their use and shall conform to the minimum requirements of this chapter.

(b) The materials entering into masonry shall be classified for the purposes of this code as follows: —

- (1) Brick.
- (2) Stone.

- (3) Cast Stone.
- (4) Concrete Blocks.
- (5) Structural Clay Tile.
- (6) Gypsum Tile.
- (7) Plain Concrete.
- (8) Plain Gypsum Concrete.
- (9) Mortar.

(c) A material of masonry other than those classified in this chapter, which is incombustible and otherwise sufficiently embodies the characteristics of one of the materials here classified, and which satisfies the requirements of this chapter for that material may be included by the commissioner in the classification of that material which it most closely resembles.

(d) The commissioner may require reasonable tests from time to time of masonry to determine their quality and whether they conform to the requirements of this chapter.

(e) Tests of masonry or of the materials thereof shall be made in accordance with the standard specifications of the American Society for Testing Materials for testing the material in question and if for any material such standard specification is not available the commissioner shall specify the method and manner of making the test.

SECTION 2403. *Brick.*—(a) Brick, as classified in this code, shall include masonry units usually about two and one quarter inches thick, three and three quarters inches wide and eight inches long. Brick shall be made of burned clay or shale, concrete, or a mixture of sand and lime.

(b) Burned clay brick shall be either solid or

hollow, but if hollow shall be at least three quarters solid.

(c) Concrete brick shall be made of Portland cement, aggregates and water as specified for concrete in Part 26.

(d) Sand-lime brick shall be made of sand, lime, and water well mixed, pressed and cured in a carefully controlled process to a uniformly hard and durable product.

(e) Brick, whether of burned clay, concrete, or sand and lime, shall be classified for strength when tested flatwise according to the following table:—

*Classification of Brick by Strength.*

GRADE.	COMPRESSIVE STRENGTH (POUNDS PER SQUARE INCH).		MODULUS OF RUPTURE (POUNDS PER SQUARE INCH).	
	Average of Five Tests.	Individual Minimum.	Average of Five Tests.	Individual Minimum.
A . . . . . .	4,500 or more	3,500	600 or more	400
B . . . . . .	2,500 to 4,500	2,000	450 or more	300
C . . . . . .	1,250 to 2,500	1,000	300 or more	200

(f) Brick for load-bearing masonry or masonry exposed to the weather shall be of Grade A or B.

(g) Brick for fire protection, fire-resistive walls, or fire-stopping shall be of Grade C or better.

**SECTION 2404. *Stone.*** — Stone for masonry shall be hard and durable. Sandstone in masonry exposed to the weather shall be laid with its natural bed horizontal.

**SECTION 2405. *Cast Stone.*** — Cast stone shall be made of Portland cement, aggregates and water with or without admixtures. Cast stone for load-bearing

masonry or exposed to the weather shall have an average compressive strength at an age of twenty-eight days of at least five thousand pounds per square inch and shall have not more than seven nor less than three per cent water absorption by weight.

**SECTION 2406. *Concrete Blocks.*** — (a) Concrete blocks, as classified in this Code, shall include hollow masonry wall units of concrete made from Portland cement, water and suitable aggregates, such as sand, gravel, crushed stone, bituminous or anthracite cinders, burned clay or shale and blast-furnace slag. The materials shall conform to the requirements for the materials of concrete specified in Part 26 except that cinder aggregate for concrete blocks shall contain not more than twenty per cent of combustible matter.

(b) Concrete blocks shall have outer shells at least five eighths inch thick and shall have strength in compression not less than two hundred and fifty pounds per square inch of gross area for an average of five blocks tested. Concrete blocks in load-bearing masonry or in masonry exposed to weather or soil shall have a strength in compression not less than one thousand pounds per square inch of gross area for an average of five blocks tested, and a minimum of seven hundred pounds per square inch for any block.

(c) Concrete blocks exposed to weather or soil in masonry shall have not more than twelve per cent water absorption by weight.

**SECTION 2407. *Structural Clay Tile.*** — (a) Structural clay tile shall consist of well burned hollow units of clay or shale.

(b) Structural clay tile shall be classified for use as follows:—

- (1) Partition Tile.
- (2) Floor Tile.
- (3) Load-Bearing Tile.

(c) Structural clay partition tile shall be classified for physical quality as Grade A or Grade B according to the following table:—

*Structural Clay Partition Tile.*

GRADE.	WATER ABSORPTION BY WEIGHT (PER CENT.).		
	Average of Five Blocks.	Individual Maximum.	Individual Minimum.
A . . . . . . . . .	5 to 16	19	4
B . . . . . . . . .	16 to 25	28	4

(d) Structural clay partition tiles of the dimensions indicated shall have the construction and dry weights given in the following table:—

*Structural Clay Partition Tile.*

DIMENSIONS (INCHES).	Minimum Number of Cells.	Minimum Weight (Pounds).
2 x 12 x 12 . . . . . . . .	3	14
3 x 12 x 12 . . . . . . . .	3	15
4 x 12 x 12 . . . . . . . .	3	16
6 x 12 x 12 . . . . . . . .	3	22
6 x 12 x 12 . . . . . . . .	4	25
8 x 12 x 12 . . . . . . . .	4	30
10 x 12 x 12 . . . . . . . .	4	35
12 x 12 x 12 . . . . . . . .	4	40

(e) Structural clay partition tile shall not be used in load-bearing masonry. Partition tile exposed to

the weather shall be Grade A. Partition tile in fire-resistive construction shall be Grade B or better. The exterior shells shall be at least five eighths inch and the interior webs at least one half inch thick.

(f) Structural clay floor tile shall be classified for physical quality as Grade A or Grade B according to the absorption table of paragraph (c) of this section for Structural Clay Partition Tile. Structural clay floor tile used in floor and roof arches shall have at least the physical qualities of the tile here classified as Grade B, as provided in Specifications for Structural Clay Floor Tile of the American Society for Testing Materials.

(g) Structural clay load-bearing tile shall be classified for physical quality as Grade A or Grade B according to the absorption table of paragraph (c) of this section, and the tile of each grade shall satisfy also the requirements for strength of the following table:—

*Structural Clay Load-Bearing Tile.*

GRADE.	COMPRESSIVE STRENGTH (POUNDS PER SQUARE INCH OF GROSS AREA).			
	END CONSTRUCTION.		SIDE CONSTRUCTION.	
	Average of Five Blocks.	Individual Minimum.	Average of Five Blocks.	Individual Minimum.
A . . . . .	1,400 or more	1,000	700 or more	500
B . . . . .	1,000 or more	700	700 or more	500

(h) Tests to establish the grade of structural clay load-bearing tile shall be made as provided in Specifications for Structural Clay Load-Bearing Wall Tile of the American Society for Testing Materials.

(i) Structural clay load-bearing tile shall have the

cellular construction and minimum weights given in the following table:—

*Structural Clay Load-Bearing Tile.*

THICKNESS IN WALL (INCHES).	Minimum Cells in Thickness of Wall.	Minimum Tile Weight per Square Foot (Pounds).
4 . . . . . . . . .	1	20
6 . . . . . . . . .	2	30
8 . . . . . . . . .	2	36
10 . . . . . . . . .	2	42
12 . . . . . . . . .	3	52

(j) Structural clay tile used in load-bearing masonry shall be load-bearing tile having at least the physical qualities of Grade B, and such tile in masonry exposed to weather or soil shall be of Grade A. Load-bearing tile shall have shells at least seven eighths inch and webs at least five eighths inch thick and shall otherwise conform to Specifications for Structural Clay Load-Bearing Wall Tile of the American Society for Testing Materials.

SECTION 2408. *Gypsum Tile.*—(a) Gypsum tile used for fire-resistive purposes shall conform to the provisions of Specifications for Gypsum Partition Tile or Block and Specifications for Gypsum of the American Society for Testing Materials.

(b) Gypsum tile shall not be used in load-bearing masonry or in masonry exposed to weather or soil.

SECTION 2409. *Plain Concrete.*—(a) Plain concrete is concrete cast in place and not reinforced, or reinforced only for shrinkage or changes of tempera-

ture. Plain concrete shall be mixed, placed and cured as specified for concrete in Part 26.

(b) Plain concrete in load-bearing masonry or where exposed to water or soil or where used for fire-resistive purposes, shall be of such proportions as to have a strength of at least fifteen hundred pounds per square inch and where exposed to wetting and freezing at least two thousand pounds per square inch as provided in Part 26.

**SECTION 2410. *Plain Gypsum Concrete.***—(a) Plain gypsum concrete is gypsum concrete cast in place, whether neat or containing a binder, and either unreinforced, or reinforced only for shrinkage and for holding in place. Gypsum concrete shall be mixed, placed and cured as specified in Part 27.

(b) Plain gypsum concrete used for fire protection shall contain not over fifteen per cent by weight of wood or other combustible binder.

**SECTION 2411. *Mortar.***—(a) Masonry, other than plain concrete and plain gypsum concrete, shall be laid in mortar except stone masonry in under-water masonry, in retaining walls not in buildings and in foundation walls below ground on both sides, which may be laid without mortar. Load-bearing masonry laid in mortar shall have full beds of mortar in which the units are placed.

(b) Mortar shall consist of a mixture of suitable proportions of Portland cement, lime, sand and water; but approved special masonry cement may be substituted for the Portland cement or lime, or both.

(c) Portland cement and sand shall conform to the

requirements for these materials in Part 26 of this code. Lime shall conform to Specifications for Quicklime for Structural Purposes or Specifications for Hydrated Lime for Structural Purposes of the American Society for Testing Materials.

(d) Lime putty shall be made by slaking to a smooth paste fresh and properly burned quicklime. The resultant paste shall be stored in a suitable box or other receptacle for not less than forty-eight hours before being mixed with sand. Hydrated lime may be substituted in equivalent amount for lime putty.

(e) Lime mortar shall be composed of one part of lime putty and not over three parts of sand by volume. Portland cement may be added to lime mortar, replacing an equal volume of lime putty, and when the cement is not less than one half the lime by volume, the working stress allowed in the masonry may be increased proportionally up to the stress specified for lime-cement mortar.

(f) Lime-cement mortar shall be composed of one part of lime putty, one part of Portland cement and not more than six parts of sand by volume. Portland cement may be added to lime-cement mortar replacing an equal volume of lime putty, and when such addition is made, the working stress allowed in the masonry may be increased proportionally up to the stress specified for cement mortar.

(g) Cement mortar shall be composed of one part of Portland cement and not more than three parts of sand by volume with an allowable addition of lime putty or hydrated lime not to exceed fifteen per cent by volume of the cement content.

(h) Mortar made of so-called "Masonry Cement" may be used. The unit stress allowed in masonry

laid with such mortar shall be determined by the commissioner after tests or other satisfactory evidence have been submitted to him, but the unit stress shall not be greater than that given in section twenty-four hundred and thirteen for masonry laid in lime-cement mortar.

(i) In proportioning mortar a sack of Portland cement weighing about ninety-four pounds shall be taken as one cubic foot and the volume of the sand shall be based on dry and loose measurement.

(j) Except as otherwise provided in paragraph (a) of this section load-bearing masonry, party walls, fire walls and masonry exposed to weather or soil shall be laid in lime mortar, lime-cement mortar, cement mortar or approved masonry cement mortar. Hollow masonry walls and masonry of hollow units shall be laid in lime-cement mortar, cement mortar or approved masonry cement mortar. Masonry likely to be under water or in contact with wet soil, if laid in mortar, shall be laid in cement mortar. Mortar or grout under metal bases of columns or beams resting upon concrete shall be made without lime.

(k) Gypsum tile walls and other non-bearing masonry walls may be laid in gypsum mortar.

SECTION 2412. *Bond in Masonry.* — Masonry walls and piers shall be bonded as provided in Part 14.

SECTION 2413. *Allowable Unit Stresses in Masonry.* — (a) In masonry walls and piers subject to axial loads the average unit compressive stress shall not exceed the values given in the following table: —

*Average Unit Compressive Stress in Masonry.*

[Pounds per square inch, gross area.]

MASONRY.	Lime Mortar.	Lime-Cement Mortar.	Cement Mortar.
<b>Brick:</b>			
Grade A . . . . .	100	200	300
Grade B . . . . .	75	150	225
<b>Cut Stone:</b>			
Granite . . . . .			
Limestone . . . . .			
Marble . . . . .	300	450	600
Sandstone . . . . .			
<b>Cast Stone</b> . . . . .			
Rubble Stone . . . . .	100	200	300
<b>Concrete Blocks</b> . . . . .	-	100	150
<b>Structural Clay Tile:</b>			
Load-Bearing Tile . . . . .	-	80	100
Floor Tile . . . . .	-	80	100

The compressive unit stress in plain concrete shall not exceed one fifth the compressive strength at twenty-eight days when determined as specified in Part 26.

(b) The unit shear in masonry shall not exceed one tenth the allowable unit compressive stress.

(c) The maximum unit stress in bending in sound natural stones used in lintels, foundations, retaining walls and elsewhere shall not exceed the values given in the following table:—

*Maximum Unit Stress in Bending.*

[Pounds per square inch.]

Granite . . . . .	180
Limestone . . . . .	140
Marble . . . . .	120
Sandstone . . . . .	100

The maximum unit stress in bending in plain concrete shall not exceed one fiftieth the compressive strength at twenty-eight days when determined as specified in Part 26.

(d) The unit bearing stress in masonry under supported beams, columns and other concentrations, and the maximum unit stress in masonry walls and piers including stress due to calculated bending and eccentric loading shall not exceed by more than twenty-five per cent, the allowable average stresses given in this section.

(e) In hollow walls or in masonry of hollow units, solid masonry shall be provided under concentrations of load to transmit the load without excessive stress.

(f) Masonry bearing walls shall have at least the thickness specified in Part 14.

SECTION 2414. *Masonry Arches.* — (a) Masonry arches shall be so designed that the line of thrust under all loadings lies within the middle third of the structural arch, or arch ring. Abutments shall be provided capable of resisting the horizontal as well as the vertical component of the thrust without settlement which would permit the line of thrust to depart from the middle third of the arch ring.

(b) The horizontal component of the arch thrust may be resisted by metal ties so placed that the horizontal component furnished by the ties, combined with the vertical supporting reaction shall be in line with the arch thrust.

(c) In the design of tie rods and beams to resist the thrust of successive masonry floor arches, the load producing the thrust shall be considered to be

the live load for interior panels and the total load for exterior panels.

**SECTION 2415. *Reinforced Masonry.*** — Lintels in masonry walls, and other approved structures, may be constructed of reinforced masonry when designed and constructed in a manner consistent with the provisions of this code and subject to the approval of the commissioner.

**SECTION 2416. *Second-Hand Materials for Masonry.*** — Second-hand brick, stone, blocks and other masonry units shall not be used in masonry unless they conform to the requirements of this code and have been thoroughly cleaned.

## PART 25.

### WOOD.

#### SECTION

- 2501 — Design of Wood.
- 2502 — Quality of Lumber.
- 2503 — Lumber Sizes and Grades.
- 2504 — Allowable Unit Stresses in Wood.
- 2505 — Wooden Columns.
- 2506 — Wooden Beams.
- 2507 — Wooden Floors and Roofs.
- 2508 — Wooden Walls and Partitions.
- 2509 — Wood Framing.

**SECTION 2501. *Design of Wood.*** — (a) Structures of wood shall be designed by methods admitting of rational analysis according to established principles of mechanics, supplemented by the assumptions herein specified, to support the loads and withstand the forces to which they are subject without exceeding the stresses allowed in this part for the various grades and species of wood.

(b) Wooden structural members shall be so framed, tied, braced and anchored as to develop the strength and rigidity necessary for the purposes for which they are used.

(c) Walls and partitions of wood shall conform to the provisions of Part 14. Floor and roof construction shall conform to the provisions of Parts 16 and 17 respectively. Wood near chimneys and heating apparatus shall conform to the provisions of Part 21.

(d) Except as otherwise provided in Part 29, wood shall not be used in the foundation of a structure. Except as otherwise provided in Parts 14, 16 and 17, wood shall not be used to support masonry.

SECTION 2502. *Quality of Lumber.*—Structural wood of the species listed in the tables of allowable unit stresses in section twenty-five hundred and four shall conform to the requirements for the several grades in specifications or grading rules of regional associations of lumber manufacturers which are based upon the grading procedure of American Lumber Standards in Simplified Practice of the United States Department of Commerce and the Guide to the Grading of Structural Timbers and the Determination of Working Stresses (Miscellaneous Publication No. 185 of the United States Department of Agriculture). The lumber of the several grades and species shall be so specified as to justify the allowable stresses in accordance with the said Guide to the Grading of Structural Timbers and the Determination of Working Stresses.

SECTION 2503. *Lumber Sizes and Grades.*—(a) The minimum sizes of wooden members specified in

this part are net sizes; for convenience nominal sizes may be used on plans submitted with applications to the commissioner for permit. Computations to determine the unit stress in wooden members shall be based upon the net or actual dimensions. American Lumber Standard dressed sizes shall be accepted as the minimum net sizes conforming to corresponding nominal sizes of lumber, and these net sizes shall be used in computations for stress unless other finished sizes are to be used and are so specified on the plans.

(b) The species, classification and grade of all wood used structurally shall be specified on the plans filed with the commissioner.

**SECTION 2504. *Allowable Unit Stresses in Wood.* —**

(a) The unit stress in wooden structural members of the several species and grades shall not exceed the allowable values specified in the following tables, computed on the net cross-section, except stresses due to wind, impact, and temporary loads and as otherwise provided in this section. The allowable stresses listed in the tables are allowed for lumber in continuously dry locations. In structures such as bridges in the open, trestles or viewing stands, which are occasionally wet but quickly dried, the unit stresses, other than shear and modulus of elasticity, shall not exceed eighty-five per cent of the listed stresses; and in structures more or less continuously damp or wet, such unit stresses shall not exceed seventy-five per cent of the listed stresses.

(b) Structural, or load-bearing lumber in buildings or other structures shall be of the grades listed in the accompanying tables for the several species except

that number one and number two common yard grades of dimension lumber may be used for form-work, other temporary purposes, boarding on joists or studs closely spaced, studs in non-bearing partitions, ceiling joists; and in buildings for rafters, floor joists and studs where the live load does not exceed fifty pounds per square foot. The unit stress in lumber of such common yard grade shall not exceed the following percentages of the corresponding stress allowed for the lowest grade listed in the tables of paragraph (a) for the same species.

*Percentage Unit Stresses in Common Yard Lumber.*

GRADE.	Bending.	Shear.	Compre- sion across Grain.	Modulus of Elasticity.	Columns.
No. 1 common . . .	90	85	90	100	85
No. 2 common . . .	65	85	90	100	65

(c) In wooden members subject to axial tension the tensile stress shall not exceed the allowable stress in bending. Compression parallel to the grain shall not exceed the stress allowed in short columns.

(d) The unit stress in wooden structural members due to wind alone or in combination with static live and dead loads shall not exceed by more than one half the allowable stresses specified in this section.

(e) When the unit stress in wooden structural members due to impact does not exceed that due to static live load the members need not be increased in size on account of impact. When the stress due to impact exceeds that due to static live load, the unit stress in the member due to impact and dead load combined shall not exceed the allowable stresses specified in this section.

*Structural Wood.*

[Allowable unit stress — pounds per square inch.]

SPECIES.	Grade.	Bending.	Shear.	Com- pression across Grain.	Modulus of Elas- ticity.
Cypress, Red (Tidewater)	Select structural .	1300	100	300	1,200,000
	Common structural .	1040	80	300	1,200,000
Douglas Fir (Coast Region)	Dense select struc- tural.	1800	120	380	1,600,000
	Select structural .	1600	100	345	1,600,000
Douglas Fir (Inland) .	Common structural <sup>1</sup>	1200	100	325	1,600,000
	Select structural .	1800	120	380	1,600,000
Douglas Fir (Inland) .	Structural . .	1600	85	335	1,500,000
	Common structural .	1200	80	315	1,500,000
Hemlock (Eastern) . .	Select structural .	1100	70	300	1,100,000
	No. 1 joists and tim- bers.	880	55	300	1,100,000
Hemlock (West Coast) .	Common structural <sup>1</sup>	1040	100	300	1,400,000
	Select structural .	1800	130	380	1,300,000
Larch . . . .	Structural . .	1600	100	345	1,300,000
	Common structural .	1200	90	325	1,300,000
Oak . . . .	Select dimension .	1400	125	500	1,500,000
	Common dimension .	1100	100	500	1,500,000
Pine, Longleaf Southern Yellow.	Select structural .	2000	125	375	1,600,000
	Prime structural .	1800	125	375	1,600,000
Pine, Dense Shortleaf Southern Yellow.	Merchantable Struc- tural.	1600	125	375	1,600,000
	No. 1 structural .	1400	125	375	1,600,000
Pine, Norway . .	Select structural .	2000	125	375	1,600,000
	Structural . .	1800	125	375	1,600,000
Red Cedar (Western) .	Structural square edge and sound .	1600	125	375	1,600,000
	No. 1 structural .	1200	125	375	1,600,000
Redwood . . . .	Select structural .	1100	85	300	1,200,000
	Prime structural .	880	65	300	1,200,000
Spruce (Eastern) . .	Structural . .	1000	100	200	1,000,000
	Common structural <sup>1</sup>	1500	80	250	1,200,000
Redwood . . . .	Select structural .	1250	70	250	1,200,000
	Heart structural .	1000	55	250	1,200,000
Spruce (Eastern) . .	Common structural (merchantable).	1000	65	300	1,200,000

<sup>1</sup> No. 1 dimension, with slope of grain not more than one in ten.

Average Unit Compression in Wooden Columns for Given Ratio of Length to Least Dimension.

SPECIES.	Grade.	SLENDERNESS RATIO L/D.										
		11 or Less.	14.	17.	20.	23.	26.	29.	32.	35.	40.	50.
Cypress, Red (Tidewater) . . .	Select structural . . .	1100	1030	948	810	622	486	391	321	268	206	132
	Common structural . . .	880	843	801	729	620	486	391	321	268	206	132
	Dense select structural . . .	1300	1235	1158	1030	828	649	521	428	358	274	175
Douglas Fir (Coast Region) . . .	Select structural . . .	1200	1148	1088	988	828	649	521	428	358	274	175
	Common structural (No. 1 dimension), (Select structural . . .)	1100	1060	1015	937	811	649	521	428	358	274	175
	Structural . . .	1466	1372	1264	1079	828	649	521	428	358	274	175
Douglas Fir (Inland) . . .	Common structural . . .	1175	1120	1056	947	776	608	489	401	336	257	154
	Select structural . . .	1050	1011	965	887	784	608	489	401	336	257	164
Hemlock (Eastern) . . .	No. 1 joists and timbers . . .	700	678	653	611	544	446	358	294	246	188	121
	Common structural (No. 1 dimension), (Select structural . . .)	560	549	536	515	480	430	358	294	246	188	121
Hemlock (West Coast) . . .	Structural . . .	1466	1325	1160	877	673	527	424	348	291	223	142
Larch . . . . .	Common structural . . .	1100	1041	970	851	673	527	424	348	291	223	142

### Average Unit Compression in Wooden Columns for Given Ratio of Length to Least Dimension — Concluded.

SPECIES.	Grade.	SLENDERNESS RATIO L/D.									
		11 or Less.	14.	17.	20.	23.	26.	29.	32.	35.	40.
Oak . . . . .	Select dimension . . . . .	1000	967	927	860	755	608	489	401	336	257
	Common dimension . . . . .	800	783	762	728	674	595	489	401	336	257
	Select structural . . . . .	1450	1360	1254	1074	828	649	521	428	358	274
Pine, Longleaf Southern Yellow . . . . .	Prime structural . . . . .	1300	1235	1158	1030	828	649	521	428	358	274
	Merchantable structural . . . . .	1200	1148	1088	988	828	649	521	428	358	274
	No. 1 structural . . . . .	1000	971	936	878	786	649	521	428	358	274
	Select structural . . . . .	1450	1360	1254	1074	828	649	521	428	358	274
	Structural . . . . .	1300	1235	1158	1030	828	649	521	428	358	274
Pine, Dense Shortleaf Southern Yellow . . . . .	Structural square edge and sound . . . . .	1200	1148	1088	988	828	649	521	428	358	274
	No. 1 structural . . . . .	850	832	810	774	717	633	521	428	358	274
	Select structural . . . . .	800	774	742	688	604	486	391	321	268	206
	Common structural . . . . .	640	627	610	582	540	476	391	321	268	206
Red Cedar (Western) . . . . .	Structural . . . . .	880	808	676	664	537	405	304	256	223	170
	Prime structural . . . . .	1245	1143	1023	822	622	486	391	321	268	206
	Select structural . . . . .	1100	1030	948	810	622	486	391	321	268	206
	Heart structural . . . . .	1000	947	886	781	622	486	391	321	268	206
Spruce (Eastern) . . . . .	Common structural (merchantable) . . . . .	640	627	610	582	540	476	391	321	268	206

(f) In temporary structures and structures subject to loading for short periods allowable stresses may be exceeded by not more than fifty per cent in the discretion of the commissioner.

(g) In joists supported on a ribbon or ledger board and spiked to the studs, the allowable unit stress in compression across the grain may exceed the allowable stresses specified in this section by not more than one half.

(h) The unit stress in compression across the grain in a limited area not over six inches long along the grain nor less than three inches from the ends of the timber may exceed the allowable stresses specified in this section by not more than the following percentages:—

LENGTH OF BEARING (INCHES).	Percentage Excess.
½	85
1	60
1½	45
2	30
3	15
4	10
6 or more	None

Intermediate values shall be determined by interpolation. The bearing stress under a washer or small plate shall not exceed that provided in this paragraph for a bearing the length of which equals the diameter of the washer or plate.

(i) Unit compressive stress on a surface inclined to the grain shall not exceed the following value:—

$$\frac{C \cdot Q}{C \cdot \sin^2 \theta + Q \cdot \cos^2 \theta}$$

in which (C) is the allowable unit compression parallel to the grain.

(Q) is the allowable unit compression across the grain.

(θ) is the angle between the direction of the pressure and the direction of the grain.

(j) The allowable unit shear specified in this section is based upon the maximum amount of checking, due to shakes or seasoning, permitted by the grading rules for each species. Lumber with greater checking than is permitted in the grading rules may be used in structures with the approval of the commissioner, provided the unit shear is proportionately less than the allowable values specified in this section.

(k) The unit shear in joint or connection details of wooden trusses or framing may exceed the values specified in this section by not exceeding fifty per cent.

SECTION 2505. *Wooden Columns.* — (a) The average unit compression in wooden columns axially loaded shall not exceed the values specified in section twenty-five hundred and four, depending upon the ratio of length to least net dimension. Intermediate values shall be determined by interpolation. The ratio of length to least dimension shall not exceed fifty.

(b) The axial load on a wooden column of round cross-section shall not exceed that allowed on a square column of the same cross-sectional area.

(c) The least lateral dimension of a tapered column for determining its slenderness ratio shall be measured at a point one third the length from the

small end but shall not be taken as more than three halves the least dimension at the small end. The average unit compression at the small end shall not exceed the allowable stress for a short column.

(d) Built up wooden columns shall have their pieces well spiked, bolted or screwed together at intervals not exceeding six times the thickness of the piece. Laminated columns shall have boards or planks in the nature of cover plates well secured to the edges of the laminations.

(e) In a built up wooden column subject to axial load the average unit compression shall not exceed three quarters of the allowable stress specified in section twenty-five hundred and four nor shall its load exceed the allowable load of a solid rectangular wooden column of which the moment of inertia about each principal axis is equal to the sum of the moments of inertia of the several pieces of the built up column about corresponding axes.

(f) Wooden columns and posts shall be squared at the ends at right angles to their axes.

(g) Wooden columns resting upon concrete or masonry which is in contact with the ground shall be separated from such concrete or masonry by an effectual seal to prevent moisture from reaching the wood through capillary action.

SECTION 2506. *Wooden Beams.* — (a) In computing the maximum unit shear in wooden beams the effect of loads not further from the center of the support than the depth of the beam may be neglected.

(b) Wooden beams notched at the end supports shall not be so loaded that the unit shear exceeds the allowable value specified in section twenty-five

hundred and four when computed by the following formula —

$$\frac{3 V h}{2 b d^2}$$

in which (V) is the shear.

- (h) is the total depth of the beam.
- (b) is the breadth of the beam.
- (d) is the depth of the beam from the bottom of the notch to the opposite face.
- (c) Unless the local unit stress is calculated and found to be not in excess of allowable stresses specified in section twenty-five hundred and four, wooden beams shall not be cut, notched or bored to clear pipes, wires, conduits or for other purposes except as follows: —
  - (1) Notches may be cut in the top or bottom not deeper than one fifth the depth of the beam and not further from the support than one fifth the span.
  - (2) Holes may be bored in the middle third of the depth and length not larger in diameter than one quarter the depth.
  - (3) Holes may be bored elsewhere in the piece limited as to size and placement the same as knots in the grade of lumber used, having due regard to the existence of knots in the piece.
  - (d) Trimmers, tail joists and headers more than eight feet long or more than four feet long where the live load exceeds fifty pounds per square foot unless framed on top of supporting beams, shall be hung in approved stirrup irons or joist hangers.
  - (e) In wooden floor and roof construction where the depth of joists is more than three times the thickness, and where the span is greater than eight feet, bridging shall be placed between joists not less than

eight feet apart nor less than eight feet from supports. Cross-bridging shall not be less than two square inches in net cross-section; and where the live load is greater than fifty pounds per square foot, not less than four square inches.

(f) Joists doubled under bearing partitions shall be well spiked together or separated by solid bridging not more than sixteen inches apart.

(g) Beams built up of timbers shall be firmly bolted together. Bolts shall be staggered and spaced longitudinally not further apart than four times the depth of the beam.

(h) Where wooden girders or beams meet at columns they shall be fitted around the columns or butted up close, and unless the post caps or bolsters provide sufficient anchorage, shall be held in place and tied through to form a continuous tie across the building sufficient to resist the wind pressure specified in Part 23 applied outwardly to the walls. Where wooden beams are supported by girders they shall be tied to form a similar continuous tie across the building.

(i) Wooden beams or girders resting upon masonry walls, or parallel to masonry walls, and nailing pieces for planking or boarding supported by masonry walls, shall be bolted or otherwise anchored to the walls in such a manner as to resist the wind pressure specified in Part 23 applied outwardly to the walls.

(j) Joists supporting a live floor or roof load not more than fifty pounds per square foot and supported at the ends by a wooden girder, may rest upon a wooden strip or cleat, not less than one and one half by three and one half inches, well spiked or otherwise secured to the girder. Such joists supporting heavier

loads shall rest on top of the girder or be hung in approved joist hangers.

(k) Nailing strips for the support of wooden joists or planking on a steel girder shall be bolted to the girder and where the live load exceeds fifty pounds per square foot shall rest upon the flanges or upon shelf angles on the web, or upon other approved support.

(l) The ends of wooden beams or girders resting upon masonry or concrete exterior, party or fire walls shall be separated from the opposite face of the wall and from beams entering the opposite face of the wall by at least four inches of solid masonry or concrete.

**SECTION 2507. *Wooden Floors and Roofs.*** — (a) Wood shall not be used in the first floor of a building where there is not a basement or cellar below, unless it has clearance above the ground of at least twenty-four inches, and the space below is ventilated either to a heated basement or to the outside air. Ventilation of such space to a heated basement shall consist of at least two remote openings in the basement wall having a total area of at least two square feet for each twenty-five linear feet of wall. Ventilation of such space to outside air shall consist of one or more openings in each exterior wall thereof, well distributed, except that openings need not be provided in the front wall when the space is ventilated in the rear and both side walls. The aggregate area of openings shall be not less than two square feet for each twenty-five linear feet of wall. Openings in exterior walls shall be protected by non-corrodible

wire mesh with openings not greater than one half inch.

(b) Rough or sub-floor boards in buildings of Type IV or Type VI shall be laid across the joists at an angle of not less than forty-five degrees. Each board shall be nailed twice at each joist. The sub-flooring shall extend to and be fitted to the rough walls and partitions.

(c) Floor boards and planking shall not penetrate a party or fire wall nor extend through a doorway in a party or fire wall. Roof boarding and planking shall not penetrate or extend over a party or fire wall.

**SECTION 2508. *Wooden Walls and Partitions.*** —

(a) Wooden stud bearing walls shall be designed to support their vertical loads without assistance from boarding or other wall covering. Bridging and other bracing shall be provided as may be necessary for this purpose and otherwise as provided in Part 14.

(b) Floor or roof girders, hip and valley rafters framing on exterior stud walls shall be supported by adequate posts.

(c) Stud partitions containing plumbing, heating or other pipes shall be so framed and the joists beneath so spaced as to provide proper clearance for the piping. Where a partition containing such piping is parallel to supporting floor joists, the joists shall be doubled under the partition, spaced to clear the piping and bridged with solid bridging.

**SECTION 2509. *Wood Framing.*** — (a) In bolted connections of wooden trusses or framing the center of a bolt shall not be less than twice its diameter from

the edge of the member. In the direction of the force transmitted the distance from the edge shall be such that the unit shear shall not exceed the allowable shear specified in section twenty-five hundred and four. The bolt shall fill the hole completely without splitting the timber. Bolts with rolled threads shall not be used in shear. Bolt threads shall be full and clean and of sufficient length to allow the nut to be screwed up tight. Washers shall be used under nuts and, except on carriage bolts, under heads. Nuts shall be concentric.

(b) Timber joints in which other fastening devices and connectors are used shall be designed and framed in accordance with good engineering practice.

## PART 26.

### REINFORCED CONCRETE.

#### SECTION

- 2601 — Design of Reinforced Concrete.
- 2602 — Definitions Pertaining to Reinforced Concrete.
- 2603 — Inspection of Concrete.
- 2604 — Tests of Materials of Reinforced Concrete.
- 2605 — Cement.
- 2606 — Concrete Aggregates.
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- 2611 — Average Concrete.
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- 2622 — Construction Joints in Concrete.
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- 2649 — Compression Reinforcement in Beams and Girders.
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## SECTION

- 2667 — Openings in Flat Slabs.
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- 2678 — Sloped or Stepped Concrete Footings.
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- 2680 — Bearing on Concrete Footings.
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**SECTION 2601. *Design of Reinforced Concrete.*** — Reinforced concrete shall be designed by methods admitting of rational analysis according to established principles of mechanics, supplemented by the assumptions herein specified, to support the loads and withstand the forces to which it is subject without exceeding the stresses allowed in this part for the various materials thereof.

**SECTION 2602. *Definitions Pertaining to Reinforced Concrete.*** — (a) The following terms are defined for use in this part of the code:—

**Aggregate:** Inert material used as a filler in concrete.

**Blast-Furnace Slag:** The non-metallic product, consisting essentially of silicates and alumino-silicates of lime, which is developed simultaneously with iron in a blast furnace.

**Column:** An upright compression member the length of which exceeds three times its least lateral dimension, excluding piles and caisson piers.

**Column Capital:** An enlargement of the upper end of a reinforced concrete column designed and built to act as a unit with the column and flat slab. A framework of metal for the same purpose.

**Column Strip:** A portion of a flat slab panel one half panel in width occupying the two quarter-panel areas outside of the middle strip. (See Middle Strip.)

**Combination Column:** A column in which a structural steel section, designed to carry the principal part of the load, is encased in concrete in such a manner that some additional load may be allowed.

**Composite Column:** A column in which the structural steel or cast iron column designed to carry the principal part of the load is encased in concrete containing reinforcement of spiral and longitudinal steel.

**Concrete:** A mixture of Portland cement, fine aggregate, coarse aggregate and water.

**Diameter:** The diameter of a square bar shall be the distance between opposite sides. The diameter of a deformed bar shall be the diameter of a plain bar having the same area of cross-section.

**Dropped Panel:** The structural portion of a flat slab which is thickened throughout an area surrounding the column capital.

**Effective Area of Concrete:** Of a cross-section, the area which lies between the centroid of the tensile reinforcement and the compression surface in a beam or slab, and having a width equal to the width of the rectangular beam or slab, or the effective width of the flange of a T-beam.

**Effective Area of Reinforcement:** The area obtained by multiplying the right cross-sectional area

of the metal reinforcement by the cosine of the angle between its direction and that for which the effectiveness of the reinforcement is to be determined.

**Flat Slab:** A concrete slab reinforced in two or more directions generally without beams or girders to transfer the loads to columns.

**Hook:** A hook made by bending a length at the end of a bar one hundred and eighty degrees about a pin of a diameter not less than five nor more than eleven bar-diameters, with a straight extension of at least four bar-diameters at the free end.

**Laitance:** Extremely fine material of little or no strength which may collect on the surface of freshly deposited concrete or mortar, usually recognized by its relatively light color.

**Middle Strip:** A portion of a flat slab panel one half panel in width, symmetrical with respect to the panel center line and extending through the panel in the direction in which bending moments are being considered.

**Panel Length:** In a flat slab, the distance along a panel side from center to center of columns.

**Pedestal:** An upright compression member whose height does not exceed three times its least lateral dimension.

**Pedestal Footing:** A column footing projecting less than one half its depth from the faces of the column on all sides and having a depth not more than three times its least width.

**Portland Cement:** The product obtained by finely

pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

**Ratio of Reinforcement:** The ratio of the effective area of the reinforcement cut by a section of a beam or slab to the effective area of the concrete at that section.

**Reinforced Concrete:** Concrete in which metal other than that provided for expansion and contraction, is embedded in such a manner that the two materials act together in resisting forces.

**Screen:** A metal plate with closely spaced circular perforations.

**Sieve:** Woven wire cloth or a metal plate with square openings of uniform size.

**Strut:** A compression member other than a column or pedestal.

**Water-Cement Ratio:** The total quantity of water entering the concrete mixture, including the surface water carried by the aggregate, expressed in terms of the quantity of cement. The water-cement ratio shall be expressed in U. S. gallons per bag (ninety-four pounds) of cement.

(b) The symbols and notations used in this part are defined as follows:—

a — Angle between inclined web bars and axis of beam.

A — Total area of pedestal, pier, or footing at the column base.

A' — Loaded area of pedestal, pier or footing at the column base.

$A_g$  — Gross area of concrete in a column.

$A_s$  — Effective cross-sectional area of steel in tension in beams and slabs, or compression in columns.

$A_v$  — Total area of cross-section of one unit of web reinforcement.

$b$  — Width of rectangular beam or width including flange of T-beam.

$b'$  — Thickness of web in beams of I or T section.

$c$  — Diameter of column capital of a flat slab.

$C_o$  — In two-way slab design, coefficient dependent on position of panel relative to adjacent continuous panels.

$C_1$  — Coefficient for bending dependent upon continuity and restraint.

$d$  — Depth of beam or slab from compression face to center of longitudinal tensile reinforcement.

$E_c$  — Modulus of elasticity of concrete in compression.

$E_s$  — Modulus of elasticity of steel (thirty million pounds per square inch).

$f_c$  — Compressive unit stress in concrete.

$f'_c$  — Ultimate compressive strength of concrete at age of twenty-eight days.

$f_s$  — Tensile unit stress in longitudinal reinforcement.

$f_v$  — Tensile unit stress in web reinforcement.

$g$  — Sum of perimeters of bars in one set.

$h$  — Unsupported length of column.

$I$  — Moment of inertia of a section about the neutral axis for bending.

$j$  — Ratio of arm of resisting couple in bending to depth (d).

- L — Span length of beam or slab; length or width of flat slab panel.
- L<sub>1</sub> — Length or width of a two-way or flat slab panel at right angles to the direction in which bending is considered.
- M — Bending moment or moment of resistance in general.
- M<sub>o</sub> — Sum of positive and negative bending moments at the principal design sections of a panel of a flat slab.
- n — Ratio of modulus of elasticity of steel to that of concrete ( $E_s/E_c$ ).
- p — Ratio of effective area of tensile reinforcement in bending, or of longitudinal reinforcement in columns to effective area of concrete.
- p' — Ratio of volume of spiral reinforcement in a column to that of the core.
- P — Total safe axial load on a short column.
- P' — Total safe axial load on a long column.
- r — Ratio of breadth to span of panel of a two-way slab.
- R — Radius of gyration of a column section.
- s — Spacing of web reinforcement measured along the axis of the beam.
- s — Distance from the center of a concentrated load to nearer support of a slab.
- t — Thickness of flange of T-beams.
- t<sub>1</sub> — Thickness of flat slab near column (including dropped panel if any).
- t<sub>2</sub> — Thickness of flat slab outside the dropped panel.
- u — Bend stress per unit of surface area of bar.
- v — Shearing unit stress.

V — Total shear at a cross-section.

V' — Excess of the total shear over the allowed resistance in shear of the concrete unreinforced.

w — Uniformly distributed load per unit length of beam or slab or per unit area.

w — Actual width of a concentrated load upon a slab.

W — Total uniformly distributed load in a single panel area.

SECTION 2603. *Inspection of Concrete.* — The commissioner shall require an applicant for a permit involving the structural use of concrete to have a competent inspector at all times on the work while such concrete is being proportioned, mixed and deposited.

SECTION 2604. *Tests of Materials of Reinforced Concrete.* — The commissioner shall have the right to require reasonable tests from time to time to determine whether the materials and methods in use are such as to produce reinforced concrete of the necessary quality. Copies of the reports of such tests shall be kept readily available by the commissioner for a period of two years after the completion of the structure.

SECTION 2605. *Cement.* — (a) Portland cement shall conform to the Standard Specifications and Tests for Portland Cement of the American Society for Testing Materials.

(b) Special cement may be used for Portland

cement, subject to the approval of the commissioner, provided it meets the requirements for Portland cement in regard to strength, soundness and setting time.

**SECTION 2606. *Concrete Aggregates.*** — (a) Concrete aggregates shall consist of graded natural sands and gravels, crushed rock, or other inert materials having clean, uncoated grains of strong and durable minerals. Aggregates containing soft, friable, thin, flaky, elongated or laminated particles totaling more than three per cent, or containing shale in excess of one and one half per cent, or silt and crusher dust finer than the number one hundred standard sieve in excess of two per cent, shall not be used. These percentages shall be based on the weight of the combined aggregate as used in the concrete. When all three groups of these deleterious materials are present in the aggregates, the combined amounts shall not exceed five per cent by weight of the combined aggregate.

(b) Burnt shale or clay, cinders, slag or other hard, clean, inert, artificial materials may be used as concrete aggregates, subject to the approval of the commissioner, provided they contain not more than one per cent by weight of sulphur or similar compounds (free or combined), nor more than ten per cent by weight of combustible matter, are properly prepared by crushing and screening to give a graded coarse and fine aggregate, and come from a source that is known to give uniform quality.

(c) Fine aggregate shall not contain organic material sufficient to give a color darker than the standard color when tested in accordance with the Standard Method of Test for Organic Impurities in

Sands for Concrete of the American Society for Testing Materials.

(d) Coarse aggregate shall not be larger than one fifth of the narrowest dimension between forms of the member in which the concrete is to be used, nor larger than three fourths of the minimum clear spacing between reinforcing bars. By maximum size of aggregate is meant the smallest sieve size through which eighty-five per cent by weight of the materials can be passed. Aggregate larger than one inch of sandstone, granite, quartzite and siliceous gravel shall not be used in fire-protective concrete.

(e) Fine aggregate shall consist of all particles passing a number four sieve.

SECTION 2607. *Water in Concrete.* — Water used in mixing concrete shall be free from injurious amounts of acids, salts, alkalies or organic materials.

SECTION 2608. *Metal Reinforcement.* — (a) Metal reinforcement shall be steel bars conforming to the requirements of the Standard Specifications for Billet-Steel Concrete Reinforcement Bars of Structural or Intermediate Grade, or for Rail-Steel Concrete Reinforcement Bars of the American Society for Testing Materials, or rerolled bars, whether from rails or from other suitable approved sections, which otherwise meet the requirements of one of the three specifications, or wire or expanded metal. The provision in these specifications for machining deformed bars before testing shall be disregarded. The tests called for in the said specifications shall always be made when rerolled steel is used.

(b) Wire for concrete reinforcement shall conform to the requirements of the Specifications for Cold-

Drawn Steel Wire for Concrete Reinforcement of the American Society for Testing Materials.

(c) Structural steel shall conform to the requirements of Part 28.

(d) Cast-iron sections for composite columns shall conform to the requirements of Part 28.

(e) Deformed bars shall have closely spaced shoulders, lugs or projections formed integrally in rolling, of such nature as to produce a bond or resistance to slipping when embedded in concrete, at least twenty-five per cent greater than that of plain hot-rolled round bars. Wire mesh with welded intersections not further apart than twelve inches (six inches in web reinforcement) in the direction of the principal reinforcing, and with cross wires of at least number ten gage, or expanded metal, may be rated for bond as deformed bars.

**SECTION 2609. *Storage of Materials for Concrete.*** — Cement and aggregates shall be stored at the work in a manner to prevent deterioration or the intrusion of foreign matter. Any material which has deteriorated or has been damaged shall not be used in concrete.

**SECTION 2610. *Concrete Quality.*** — (a) The allowable unit stresses for the design of reinforced concrete structures shall be based upon the twenty-eight-day strength of the concrete to be used in the structure in accordance with the values given in section twenty-six hundred and twenty-nine. Plans submitted for approval or used on the work shall clearly show the strength of concrete for which all parts of the structure were designed. The strength of concrete shall be determined in accordance with one of the following methods:—

(1) By established results for average materials as provided in section twenty-six hundred and eleven (Average Concrete).

(2) By specific test of materials for the structure as provided in section twenty-six hundred and twelve (Controlled Concrete).

(b) Structural concrete made with artificial aggregates, with special cements, or with admixtures, shall always be made in accordance with method (2) for controlled concrete. (The water-cement ratio strength relation will generally be different than for natural aggregates, normal cement, or usual mixtures). The commissioner may waive the requirements of this paragraph subject to such conditions as he may specify.

SECTION 2611. *Average Concrete.* — (a) The following table gives the compressive strength in pounds per square inch which shall be assumed as the basis for design where no preliminary concrete strength tests of the materials to be used are made. A bag of cement weighing ninety-four pounds shall be assumed to measure one cubic foot.

*Assumed Strengths of Concrete Mixtures.*

Minimum Proportions: Volume of Portland Cement to Sum of Separate Volumes of Fine and Coarse Aggregates, measured Dry and Loose.	Maximum Water-Cement Ratio, United States Gallons per Bag of Cement. <sup>1</sup>	Assumed Compressive Strength at 28 Days (Pounds per Square Inch).
1:7½	8.00	1,500
1:6	7.25	2,000
1:5	6.50	2,500
1:4	6.00	3,000
1:3	5.00	3,750

<sup>1</sup> Including the water content of the aggregate. Unless this content is determined by tests, it shall be assumed to be one half gallon per cubic foot of fine aggregate.

(b) During the progress of the work, such reasonable number of compression tests shall be made as may be required by the commissioner, but at least one set of specimens shall be tested for each three hundred cubic yards of each different mixture of concrete being placed. The tests shall be made in accordance with provisions of section twenty-six hundred and thirteen. If the average twenty-eight-day strength falls below the strength called for on the plans, the commissioner shall have the right to require a load test under the provisions of Part 23. The commissioner may waive the requirement of tests on work involving in all less than two hundred cubic yards of concrete.

(c) Average concrete exposed to the weather shall contain not less than six bags of cement per cubic yard of concrete and the water-cement ratio shall not exceed six gallons per bag of cement.

SECTION 2612. *Controlled Concrete.* — (a) When the proportions are to be established by tests, the tests shall be made in advance of the beginning of construction using the materials proposed and consistencies suitable for the work and in accordance with the provisions of section twenty-six hundred and thirteen. The relation between the average twenty-eight-day strength of the concrete and the water-cement ratio shall be determined by such tests for a range of values including all of the strengths called for on the plans. The water-cement ratio determined for each quality of concrete to be used shall allow sufficient margin of strength to provide for the exigencies of field operations. In no case, however, shall concrete exposed to the weather contain less

than five bags of cement per cubic yard of concrete or have a water-cement ratio in excess of six gallons per bag. No change or substitution shall be made in the materials being used on the work without additional tests to determine the new water-cement ratios to be used.

(b) During the progress of the work, a reasonable number of compression tests may be required by the commissioner, but at least one set of specimens shall be tested for each one hundred and fifty cubic yards of concrete of a given strength, and not less than one set of specimens of each strength of concrete for each day's operation. Such tests shall be made in accordance with the provisions of section twenty-six hundred and thirteen. If the average twenty-eight-day strength of the tested specimens for any portion of the structure falls below the strength called for on the plans, the commissioner shall have the right to require load tests as specified in Part 23 on the portions of the building affected, and to order a change in the mixture for the remaining portion of the structure.

(c) Controlled concrete shall be proportioned, mixed and placed under the supervision of an approved concrete control engineer.

**SECTION 2613. *Field Tests of Concrete.*** — (a) Specimens for compression tests of concrete, when required, shall be made and stored in accordance with the Standard Method of Making and Storing Compression Test Specimens of Concrete in the Field, and tested in accordance with the Standard Method of Making Compression Tests of Concrete, of the American Society for Testing Materials; pro-

vided, that each set shall consist of at least three specimens which shall be stored under moist curing conditions at seventy degrees Fahrenheit, and no specimens need be stored on the structure.

(b) If tests disclose a consistent relation between the seven-day and the twenty-eight-day strength of the concrete, the tests required during the progress of concrete work may be made at seven days and the strength at twenty-eight days determined therefrom.

**SECTION 2614. *Concrete Proportions and Consistencies.*** — (a) The proportions of cement and aggregates for concrete shall be such as to produce concrete that will work readily into the corners and angles of the forms and around the reinforcement without excessive puddling or spading and without permitting the materials to segregate or free water to collect on the surface. The combined aggregate shall be of such composition of sizes that when separated by a number four standard sieve, the weight retained on the sieve shall not be less than one third nor more than two thirds of the total. The consistency of the concrete shall be such that the slump as measured by the slump test shall not exceed the values given in the following table:—

CLASS OF CONCRETE.	Maximum Allowable Slump.
Heavy foundations, massive walls . . . . .	4 inches
Other reinforced concrete . . . . .	6 inches

(b) The methods of measuring concrete materials shall be such that the proportion of all ingredients including water can be accurately controlled during

the progress of the work and easily checked at any time by the commissioner.

SECTION 2615. *Mixing Concrete.*—Concrete shall be mixed until there is a uniform distribution of the materials and the mass is homogeneous and uniform in color. In machine mixing, only batch mixers shall be used. Each batch shall be mixed not less than one minute after all the materials are in the mixer and must be completely discharged before the mixer is recharged.

SECTION 2616. *Concrete Forms and Equipment.*—(a) Forms shall be substantial and sufficiently tight to prevent loss of mortar from the concrete.

(b) Before concrete is placed equipment for mixing and transporting the concrete and forms shall be clean; the spaces to be occupied by the concrete shall be free of snow, ice and debris.

SECTION 2617. *Removal of Water from Excavations.*—Water shall be removed from excavations before concrete is deposited, unless otherwise directed by the commissioner. Water flowing into an excavation shall be diverted through proper side drains to a sump, or be removed by other approved methods which will avoid washing the freshly deposited concrete.

SECTION 2618. *Transporting Concrete.*—(a) Concrete shall be handled from the mixer to the place of final deposit by methods which will prevent the separation or loss of the ingredients. Under no circumstances shall concrete that is partially hardened be deposited in the work.

(b) Concrete otherwise meeting the requirements of this code but mixed at a distance from the structure in which it is to be deposited may be used provided the time elapsed between addition of the cement to the aggregate and its deposit in the forms does not exceed one hour.

SECTION 2619. *Placing Concrete.* — (a) Concrete shall not be placed until the forms and reinforcement have been inspected and approved by the inspector required by section twenty-six hundred and three.

(b) When concreting is once started, it shall be carried on as a continuous operation until the placing of the section or panel is completed. The top surface shall be kept generally level and accumulations of water on the surface shall be promptly removed. Where construction joints are necessary, they shall be made in accordance with section twenty-six hundred and twenty-two.

(c) Concrete shall be thoroughly compacted by puddling with suitable tools during the operation of placing, and thoroughly worked around the reinforcement.

SECTION 2620. *Depositing Concrete in Cold Weather.* — When depositing concrete at freezing or near freezing temperature, the concrete shall be maintained at a temperature of not less than fifty degrees Fahrenheit, and not more than one hundred and twenty degrees. The temperature of the concrete shall be maintained at not less than fifty degrees for at least seventy-two hours after placing. When necessary, concrete materials shall be heated before mixing. Dependence shall not be placed on salt or other chemicals for the prevention of freezing.

SECTION 2621. *Curing Concrete.*—(a) Exposed surfaces of concrete shall be kept moist for a period of at least seven days after being deposited.

(b) Forms shall be removed in such a manner and with such precautions as to insure complete safety of the structure.

SECTION 2622. *Construction Joints in Concrete.*—Joints not indicated on the plans shall be so made and located as least to impair the strength of the structure. Such joints in floors shall be located near the middle of spans of slabs, beams, or girders, unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset a distance equal to twice the width of the beam. At least two hours must elapse after depositing concrete in columns or walls before depositing in beams, girders, or slabs supported thereon. Beams, girders, brackets, column capitals, and haunches shall be considered part of the floor system and shall be placed monolithically herewith. All joints shall be bonded in accordance with section twenty-six hundred and twenty-three. (For construction joints in flat slabs, see also section twenty-six hundred and sixty-eight.)

SECTION 2623. *Bonding Fresh and Hardened Concrete.*—Before new concrete is deposited on or against concrete which has set, the surface of the set concrete shall be roughened, cleaned of foreign matter and laitance and thoroughly wetted but not saturated. The cleaned and wetted surfaces of the hardened concrete, including vertical and inclined surfaces, shall first be slushed with a coating of neat

cement grout, against which, before it has attained its initial set, the new concrete shall be placed.

**SECTION 2624. *Bending Reinforcement.*** — Metal reinforcement shall not be bent, straightened or handled in any manner that will injure the material. Reinforcement may be heated only when approved by the commissioner. Cold bends shall be made around a pin having a diameter of not less than four times the diameter of the bar. Bars with kinks or bends not shown on the plans shall not be used.

**SECTION 2625. *Placing Reinforcement.*** — (a) Metal reinforcement shall be clean and free of loose mill and rust scale and of other coatings that would destroy or reduce the bond. It shall be accurately placed, supported and secured.

(b) The minimum clear distance between parallel bars shall be one and one half times the diameter for round bars and twice the diameter for square bars. If the ends of bars are anchored as specified in section twenty-six hundred and forty-five, the clear spacing may be made equal to the diameter of round bars or to one and one half times the diameter of square bars, but in no case shall the spacing between bars be less than one inch, nor less than one and one third times the maximum size of the coarse aggregate. The minimum clear distance between bars and forms shall be the diameter of round bars and one and one half times the diameter of square bars. Bars shall be embedded a distance from the face of a member not less than the distance required for fire and rust protection in this code. The main longi-

tudinal steel of a reinforced concrete slab shall be spaced not more than three times the slab thickness.

**SECTION 2626. *Splices in Reinforcement.*** — (a) In slabs, beams and girders, splices of reinforcement shall generally be avoided at points of maximum stress and, where made, shall provide sufficient lap to transfer the stress by bond and shear.

(b) In columns longitudinal reinforcement may be spliced by lapping the bars a length sufficient to develop the working stress in the reinforcement by means of bond, but in no case shall the lap be less than twenty-four bar diameters for deformed bars or thirty diameters for plain bars. Butt joints of approved design are permitted at points where only compressive stress occurs.

**SECTION 2627. *Protective Covering of Reinforcement.*** — (a) At the underside of footings and elsewhere in concrete poured in contact with the ground, the main metal reinforcement shall have a minimum covering of three inches except that in floor slabs poured on dry earth such covering may be one and one half inches. In concrete poured in forms but exposed to soil backfill, moisture or weather, such covering shall be two inches.

(b) In buildings of Type I and Type II construction, and in other reinforced concrete required to have specified fire resistance, main metal reinforcement shall be protected as required in sections one hundred and twenty-four to one hundred and thirty-one, inclusive, of Part 1, in Parts 16, 17 and 22, respectively, and elsewhere in this code.

(c) Bars used for the support or spacing of reinforcement, shrinkage reinforcement, column ties and

stirrups not over one half inch in diameter, shall not be considered main reinforcement. Such bars shall have minimum protective covering one half inch less than specified in this section for main reinforcement.

*SECTION 2628. Pipes and Conduits Embedded in Concrete.*—Pipes which will contain liquid, gas or vapor at other than room temperature shall not be embedded in concrete necessary for structural stability or fire protection. Drain pipes and pipes whose contents will be under pressure greater than atmospheric pressure by more than one pound per square inch shall not be embedded in structural concrete except in passing through from one side to the other of a floor, wall or beam. Electric conduits and other pipes embedment of which is allowed shall not, with their fittings, displace that concrete of a column on which stress is calculated or which is required for fire protection, to greater extent than four per cent of the area of cross-section. Sleeves or other pipes passing through floors, walls or beams shall not be of such size or in such location as unduly to impair the strength of the construction; such sleeves or pipes may be considered as replacing structurally the displaced concrete, provided they are not exposed to rusting or other deterioration, are of galvanized or uncoated iron or steel not thinner than standard wrought iron pipe, have a nominal inside diameter not over two inches, and are spaced not less than three diameters on centers. Embedded pipes or conduits other than those merely passing through shall not be larger in outside diameter than one third the thickness of the slab, wall or beam in which they are embedded, shall not be spaced closer than three diameters on centers, nor so located as unduly to

impair the strength of the construction. Circular uncoated or galvanized electric conduit of iron or steel may be considered as replacing the displaced concrete.

SECTION 2629. *Allowable Unit Stresses in Concrete.* — (a) Reinforced concrete members shall be designed with reference to safe loads and working stresses. The unit stresses in pounds per square inch in concrete of the strength indicated shall not exceed the following allowable values, where ( $f'_c$ ) is the strength of twenty-eight days: —

KIND OF STRESS.	Expressed as a Proportion of the Strength.	ALLOWABLE UNIT STRESSES.		
		SPECIFIC VALUES FOR COMMON STRENGTHS (POUNDS PER SQUARE INCH).		
		Strength.		
		2,000.	2,500.	3,000.
<i>Flexure:</i>				
Extreme fiber stress in compression . . .	0.40 $f'_c$	800	1,000	1,200
<i>Shear:</i>				
Beams with no web reinforcement and without special anchorage of longitudinal steel	0.02 $f'_c$	40	50	60
Beams with no web reinforcement, but with special anchorage of longitudinal steel	0.03 $f'_c$	60	75	90
Beams with web reinforcement but without special anchorage of longitudinal steel	0.06 $f'_c$	120	150	180
Beams with web reinforcement and with special anchorage of longitudinal steel	0.09 $f'_c$	180	225	270
Flat slabs at distance ( $d$ ) from edge of column cap or drop panel (see also section 2641) .	0.025 $f'_c$	50	62	75
Footings (see also section 2642) . . .	0.02 $f'_c$	40	50	60
<i>Bond:</i>				
Plain bars . . . . .	0.04 $f'_c$	80	100	120
Deformed bars . . . . .	0.05 $f'_c$	100	125	150
<i>Bearing:</i>				
On full area . . . . .	0.25 $f'_c$	500	625	750
On one third area . . . . .	0.375 $f'_c$	750	937	1,125
<i>Axial Compression:</i>				
In columns with lateral ties . . . . .	0.20 $f'_c$	400	500	600
In columns with continuous spirals enclosing a circular core . . . . .	0.25 $f'_c$	500	625	750

(b) The bond stress computed in accordance with section twenty-six hundred and forty-three may be allowed to reach double these values where special anchorage is provided as specified in section twenty-six hundred and forty-five.

(c) The allowed bearing stress on an area greater than one third but less than the full area shall be interpolated between the values given in the table.

(d) The ratio of the moduli of elasticity of steel and concrete shall be assumed as (n) =  $\frac{30,000}{f'_c}$ .

#### SECTION 2630. *Allowable Unit Stresses in Steel.*

— (a) The following allowable unit stresses shall not be exceeded in reinforcing steel.

##### *Allowable Unit Stress (Pounds per Square Inch).*

###### Tension:

Structural or intermediate grade billet steel bars	18,000
Rerolled steel bars	18,000
Cold drawn steel wire or cold stretched expanded metal fabric	20,000
Web reinforcement (steel)	16,000
Other steel reinforcement fifty per cent of the yield point, but not to exceed	18,000

(b) Compression in reinforcing steel except in columns, shall not exceed (n) times the compressive stress in the concrete at a line in the cross-section through the center of the bars.

(c) Compression in structural steel and cast iron in composite and combination columns shall not exceed the stress specified in sections twenty-six hundred and seventy-five and twenty-six hundred and seventy-six.

(d) The modulus of elasticity shall be assumed as thirty million pounds per square inch.

**SECTION 2631. *Design of Reinforced Concrete for Wind Loads.*** — In designing the members of reinforced concrete structures to resist wind loads, the allowable unit stresses for dead and live load and wind loads may be increased to four thirds of the allowable values specified in sections twenty-six hundred and twenty-nine and twenty-six hundred and thirty, but no member shall be less than that required if the wind load be neglected.

**SECTION 2632. *Design of Reinforced Concrete in Flexure.*** — (a) The accepted theory of flexure as applied to reinforced concrete shall be applied to all members resisting bending. The following assumptions shall be made: —

- (1) The steel alone resists tensile stress and acts only in the direction of its length.
- (2) The ratio ( $n$ ) of the modulus of elasticity of the steel either in tension or compression to that of any given concrete is constant.

(3) Plane sections before bending remain plane after bending.

(b) Beams and slabs shall be designed to resist safely the actual bending and shear produced by the loads and supporting forces under the existing conditions of end restraint or continuity. It is the intent of this part to require that the bending moments throughout the spans be determined so far as possible consistently with the elastic deformation of the structure, being in general calculated according to the provisions of section twenty-six hundred and thirty-five by methods of elastic analysis; but they may in the special cases and with the limitations described in section twenty-six hundred and thirty-six be approximated by the use of arbitrary moment

coefficients as provided therein. Wherever negative bending may occur, the full amount thereof shall be provided for, except in slabs thirty inches or less in span.

**SECTION 2633. *Span Length of Reinforced Concrete Members.*** — (a) The span length of freely supported beams and slabs shall be the distance between centers of bearings, but need not exceed the clear span plus the depth of beam or slab.

(b) The span length for continuous or restrained beams and slabs built to act integrally with supports shall be the clear distance between faces of supports, the spaces occupied by supports where restraint or continuity occurs being suppressed in the force and moment diagrams.

(c) For continuous beams having brackets built to act integrally with both beam and support and of a width not less than the width of the beam and making an angle of forty-five degrees or more with the beam, the span shall be measured from the section where the combined depth of the beam and bracket is at least one third more than the depth of the beam. Brackets making an angle of less than forty-five degrees with the beam may be considered as increasing the effective depth of the beam, but not as decreasing the span length. Beams shall be designed to resist at each section the bending there occurring.

(d) Maximum negative moments are to be considered as existing at the ends of the span, as defined above.

**SECTION 2634. *Depth of Reinforced Concrete Beams or Slabs.*** — The depth of the beam or slab shall be taken as the distance from the center of

gravity of the tensile reinforcement to the compressive surface of the structural member. In stores, warehouses and manufacturing buildings, where a wearing finish placed monolithic with the structural slab is considered in design to be part of the structural slab or beam, the effective depth shall be measured to a plane one half inch below the finished surface.

**SECTION 2635. *Analysis of Bending in Reinforced Concrete.*** — (a) The determination of bending moments to be provided for at various points in the span of a member restrained at supports, or a series of continuous spans, in accordance with section twenty-six hundred and thirty-two, shall be made by application of the theorem of three moments, principle of least work, or equivalent method based on elastic deformation, and shall be subject to the following qualifications:—

- (1) Supports afforded by beams, girders and columns of usual arrangement shall be assumed to be and remain in alignment conforming to the position of the unloaded beam or slab.
- (2) The effect on bending moments in the spans produced by the torsional resistance of interior supporting beams and by the bending resistance of ordinary interior supporting columns may be neglected, and shall be neglected unless the restraint is computed and provided for in the supports. Restraint at exterior supports shall be provided for both in the spans and in the supports.

- (3) The difference in moment of inertia of beams of approximately the same depth in different spans and of the same beam acting to resist positive and

negative bending, may be considered negligible so far as regards its effect on distribution of moment throughout the spans. The moment of inertia may be calculated from the gross section of the concrete neglecting reinforcement and the flanges of T-beams may be neglected.

(4) Design for bending, both positive and negative, that may occur within a span shall include consideration of the effects of a partial distribution of load on the span itself and either or both adjacent spans, but not on spans more remote than these. Maximum negative moment at a support may be assumed to result from full loading on adjacent spans only.

(b) The commissioner may approve analyses conforming to the intent of this part, based on accepted theory, and incorporating refinements other than these provided herein; and he may require special analysis for extraordinary conditions of support, restraint, span lengths and distribution of load.

**SECTION 2636. *Arbitrary Moment Coefficients for Reinforced Concrete.***—(a) In the case of a beam or a slab, or a series of continuous beams or slabs with spans differing not more than twenty-five per cent of the longer span, uniformly loaded, and falling within one of the specified cases of restraint at the supports, designs may be made to resist bending moments computed by the arbitrary coefficients presented in this section, instead of by elastic analysis.

(b) The coefficients of  $(wL^2)$  set forth in the following table may be used to compute the positive bending at mid-span and the negative bending at

supports in the locations and under the conditions indicated.

*Table of Arbitrary Coefficients for Bending.*

CONDITIONS OF RESTRAINT.	Number of Spans.	END SPAN.		First Interior Support.	INTERIOR SPANS.	
		End Support.	Mid-Span.		Mid-Span.	Other Interior Supports.
<i>Case 1:</i> Slabs or beams with negligible restraint at end supports.	$\begin{cases} 1 \\ 2 \\ \text{Mult.} \end{cases}$	$\begin{cases} 1/24 \\ 1/24 \\ 1/24 \end{cases}$	$\begin{cases} 1/8 \\ 1/10 \\ 1/12 \end{cases}$	$\begin{cases} - \\ 1/8 \\ 1/9^1 \end{cases}$	$\begin{cases} - \\ - \\ 1/16 \end{cases}$	$\begin{cases} - \\ - \\ 1/12 \end{cases}$
<i>Case 2:</i> Slabs or beams with moderate restraint at end supports.	$\begin{cases} 1 \\ 2 \\ \text{Mult.} \end{cases}$	$\begin{cases} 1/16 \\ 1/16 \\ 1/16 \end{cases}$	$\begin{cases} 1/10 \\ 1/12 \\ 1/14 \end{cases}$	$\begin{cases} - \\ 1/9 \\ 1/10 \end{cases}$	$\begin{cases} - \\ - \\ 1/16 \end{cases}$	$\begin{cases} - \\ - \\ 1/12 \end{cases}$
<i>Case 3:</i> Slabs or beams with full restraint at end supports.	$\begin{cases} 1 \\ 2 \\ \text{Mult.} \end{cases}$	$\begin{cases} 1/12 \\ 1/12 \\ 1/12 \end{cases}$	$\begin{cases} 1/12 \\ 1/16 \\ 1/16 \end{cases}$	$\begin{cases} - \\ 1/10 \\ 1/11 \end{cases}$	$\begin{cases} - \\ - \\ 1/16 \end{cases}$	$\begin{cases} - \\ - \\ 1/12 \end{cases}$

<sup>1</sup> One tenth for slabs.

(c) In the use of this table negligible restraint shall be assumed for slabs supported on walls of masonry units, or on the upper flanges of steel beams not encased in concrete; and for beams supported on steel or cast iron columns not encased in concrete, or on combination columns, or on masonry piers or walls of any type other than reinforced concrete columns acting integrally therewith, or by other beams or girders; or on any supports which do not assure as great restraint as that described as "moderate."

(d) Moderate restraint may be assumed for slabs supported by reinforced concrete beams, or by steel beams encased in concrete, or by reinforced concrete walls; and for beams or girders supported on composite columns, or on reinforced concrete columns, provided the slabs or beams act integrally with the support.

(e) Full restraint may be assumed only for slabs

acting integrally with supporting reinforced concrete walls and for beams or girders acting integrally with reinforced concrete columns, when  $(I/L)$  for the slab, beam or girder is less than the sum of the values of  $(I/h)$  for the walls or columns, respectively, above and below. In this section  $(I)$  represents the moment of inertia, calculated for the gross section of the concrete, neglecting reinforcement and the flanges of T-beams.  $(L)$  and  $(h)$  are span length and column or wall height, respectively.

(f) In calculating negative bending at a support between two spans of unequal load or length, the average unit load over the two spans shall be used, and an assumed span which is two thirds the longer span plus one third the shorter span.

(g) For continuous or restrained beams or girders subject to equal concentrated loads which occur at approximately regular intervals with a concentration at each support, the positive and negative bending may be determined as though the entire load were distributed uniformly on the beam or girder.

**SECTION 2637. *Points of Inflection in Reinforced Concrete, and Shear.***—The location of points of inflection, reactions and shears, shall be assumed consistently with the loading and the computed distribution of bending moments. In the three cases of slabs and beams of two or more continuous spans when the arbitrary coefficients for bending of section twenty-six hundred and thirty-six may be applied, the reactions on end supports shall be taken as forty per cent Case 1, forty-five per cent for Case 2, and fifty per cent for Case 3, of the load on the end span, and the reaction on the first interior support shall be

computed accordingly; the loads on interior spans may be assumed as evenly divided between supports in determining shears and reactions.

**SECTION 2638. *Diagonal Tension in Reinforced Concrete Beams.*** — (a) Reinforced concrete beams (including ribs of ribbed and combination slabs, and other members subject to bending) shall be designed to resist the diagonal tension in their webs without exceeding the stresses prescribed in sections twenty-six hundred and twenty-nine and twenty-six hundred and thirty.

(b) For the purpose of design, the diagonal tension in the web of a beam shall be assumed to be directed at an angle of forty-five degrees with the axis of the beam, and its intensity to be equal to the unit shear, computed by the formula:

$$v = \frac{V}{b'jd}$$

In this formula ( $b'$ ) is to be taken as the width of the concrete section between the tensile steel and the compressive flange, the average width if the sides slope but not over twenty per cent more than the minimum.

(c) Beams in which the diagonal tension in any portion of the web exceeds the stress allowed in beams without web reinforcement shall be reinforced in that portion for the excess.

**SECTION 2639. *Types of Web Reinforcement.*** — (a) Web reinforcement shall consist of vertical stirrups or of stirrups or bars inclined at an angle of

not less than fifteen degrees with the axis of the beam.

(b) Web reinforcement shall be considered effective only to the extent that its stress can be developed by bond and anchorage as provided in section twenty-six hundred and forty-six.

**SECTION 2640. *Design of Web Reinforcement.* —**

(a) A web reinforcing bar, whether vertical or inclined, shall be considered to afford for resistance to diagonal tension the component of its tensile stress in the direction of the diagonal tension. The spacing of stirrups (or the length of beam over which the resistance of a stirrup or bar is effective) is therefore determined by the following formula:

$$s = \frac{A_v f_v jd (\cos a + \sin a)}{V'}$$

For vertical stirrups this becomes —

$$s = \frac{A_v f_v jd}{V'}$$

And for stirrups or bars inclined at forty-five degrees —

$$s = \frac{A_v f_v jd}{0.7 V'}$$

(b) In the formulas of this section ( $V'$ ) is the shear in the beam at any cross-section in excess of the allowed resistance of the unreinforced web, and it shall be subject to the limitation imposed upon the unit shear by section twenty-six hundred and twenty-nine. The spacing ( $s$ ) of stirrups, vertical or inclined, or of bars inclined at not less than forty-five degrees

shall not exceed three fourths the effective depth of the beam. In the case of bars inclined at less than forty-five degrees, (s) shall not exceed three fourths the axial projection of the inclined length.

(c) In portions of beams where the unit shear exceeds  $(0.06 f'_c)$  the limits for (s) shall be reduced by changing the fraction three fourths to one half in the preceding paragraph.

**SECTION 2641. *Shearing Stress in Concrete Flat Slabs.*** — (a) In flat slabs, the shearing unit stress on a vertical section which lies at a distance (d) from the edge of the column capital and parallel with it, shall not exceed the following allowable values when computed by the formula given in section twenty-six hundred and thirty-eight for shearing unit stress in beams.

(1)  $0.03 f'_c$  — when at least fifty per cent of the total negative reinforcement in each column strip passes directly over the column capital.

(2)  $0.025 f'_c$  — when twenty-five per cent of the total negative reinforcement in each column strip passes directly over the column capital (which is the least that shall be permitted).

(3) For intermediate percentages, proportionate intermediate values of the allowable shearing unit stress shall be used.

(b) In flat slabs, the shearing unit stress on a vertical section which lies at a distance (d) from the edge of the dropped panel and parallel with it shall not exceed  $(0.03 f'_c)$ .

(c) For the purposes of this section (d) shall be the average depth at the section in question from the compressive surface of the concrete to

the center of the tensile reinforcement for negative bending.

**SECTION 2642. *Shear and Diagonal Tension in Footings.*** — (a) The shearing unit stress computed by the formula given in section twenty-six hundred and thirty-eight on any vertical peripheral or plane section of a footing at a distance (d) from the face of the supported column or pier and parallel with it, shall not exceed  $(0.02 f'_c)$  for footings with straight bars, nor  $(0.03 f'_c)$  for footings in which the bars have special anchorage as specified in section twenty-six hundred and forty-five.

(b) In footings supported on piles, the critical section for diagonal tension shall be considered at a distance  $(d/2)$  from the face of the supported column or pedestal and any piles whose centers are at this section or nearer the supported column or pedestal shall be excluded in computing the shear.

**SECTION 2643. *Bond Stress in Reinforced Concrete.*** — (a) Members subject to bending shall be so proportioned that the increments of stress in the tensile steel are transmitted to it from the concrete in which it is embedded, without producing bond stress exceeding that specified in section twenty-six hundred and twenty-nine.

(b) In beams in which the tensile reinforcement is parallel to the compressive face, and is not specially anchored, the bond stress (u) shall be assumed to be determined by the following formula: —

$$u = \frac{V}{g jd}$$

(c) In non-prismatic or wedge-shaped beams, as represented by a cantilever bracket, a sloped top footing, or a beam with cambered compressive face, in which the depth of the beam is increased in the direction of increasing bending moment, the bond stress is not proportional to the shear, being at all sections smaller than indicated by the formula of paragraph (b) for a prismatic beam of depth equal to the depth at the section considered. For such beams the bond stress shall be assumed to be determined by the following formula:—

$$u = \frac{V}{g jd} \times \left(1 - m \frac{M}{Vd}\right)$$

in which (m) is the tangent of the angle between the compressive face and the tensile re-inforcement.

(d) Adequate end anchorage of bars in prismatic beams which are subject to excessive bond stress, as computed by the formula of paragraph (b), may result in the relief of such excessive bond stress, by inducing in the beam an arch action, with distribution of bending stresses analogous to that in a cambered beam. About bars so anchored the computed bond stress may be double that allowed for unanchored reinforcement.

(e) Special anchorage adequate to justify increased bond stress shall be capable of developing the maximum tension in the bars in excess of that developed by bond at its allowable value. The excess tension ( $T'$ ) shall be determined by the formula:—

$$T' = T \left(1 - \frac{u'}{u}\right)$$

in which (T) is the maximum tensile stress.

(u') is the allowable stress in bond for unanchored reinforcement.

(u) is the maximum bond stress computed by one of the formulas of paragraphs (b) and (c).

(f) In simply supported beams the required special anchorage shall be provided beyond the face of the support. In continuous beams sufficient special anchorage of the positive reinforcement beyond the point of inflection may be considered to be provided by the extension of such bars to the ends of the span. For the negative reinforcement of restrained or continuous beams, and for the tensile reinforcement of cantilevers, brackets and footings, the required special anchorage shall be provided by extending or hooking the bars beyond the point at which tension begins.

(g) In applying the formulas of paragraphs (b) and (c) to any section of a beam in which the tensile reinforcement is varied by bending or discontinuing a portion of the bars, there shall be counted as contributing their perimeters to bond resistance only those bars at that section and in the plane of the main longitudinal tensile steel, in which tensile stress is increasing consistently with the assumptions under which the beam is designed.

**SECTION 2644. Ordinary Anchorage of Reinforcement.** — (a) Reinforcement acting in tension at a restrained end of a beam or in a cantilever shall have anchorage on both sides of the face of the support and beyond the point where any portion of the rein-

forcement is discontinued sufficient to develop the tension in each of the bars.

(b) In a restrained beam at least one third of the tensile reinforcement for negative bending shall be extended at least to the point of inflection of the beam.

(c) At least one fourth of the tensile reinforcement for positive bending in a beam shall be extended at least to the end of the span. Bars not so extended may be bent across the web, becoming continuous with the negative reinforcement, or otherwise anchored in a region of compression.

**SECTION 2645. *Special Anchorage of Reinforcement.*** — (a) Where, by reasons of special anchorage of reinforcement, increased shearing stresses are allowed, reinforcement in the proportions specified in section twenty-six hundred and forty-four shall be extended in beams as there specified, and anchorage shall further be provided beyond the points of inflection for the negative reinforcement of restrained beams, and beyond the end of the span for positive reinforcement of freely supported beams, sufficient to develop at least one half of their allowable tensile stress. In footings, special anchorage justifying increased shearing stress shall be considered as provided when all bars are anchored by means of hooks at their ends. The outer face of hooks shall be as close to the face of the footing as the requirements for rust protection will allow.

(b) Where anchorage is furnished by extension of the bars, such extension may be assumed to provide an anchorage capacity equal to the embedded surface multiplied by the allowable unit bond resist-

ance specified in section twenty-six hundred and twenty-nine. A hook, for the purpose of this section, means a complete semicircular hook as defined in section twenty-six hundred and two. Such a hook may be assumed to develop a stress of not more than ten thousand pounds per square inch in the bar so anchored. A bend of larger radius than allowed in a hook shall be considered as a mere extension of the bar.

**SECTION 2646. *Anchorage of Web Reinforcement.***

— (a) The stress in a stirrup or web reinforcement bar for resistance of diagonal tension in a beam shall not exceed the capacity of its anchorage in the upper or lower one half of the effective depth of the beam nor the allowable stress specified in section twenty-six hundred and thirty.

(b) Web reinforcement which is provided by bending into an inclined position one or more bars of the main tensile reinforcement where not required for resistance to positive or negative bending shall be considered completely anchored by continuity with the main tensile reinforcement or by embedment of requisite length in the upper or lower half of the beam, provided at least one half of such embedment is as close to the upper or lower surface of the beam as the requirements of fire or rust protection allow. A hook placed close to the upper or lower surface of the beam may be substituted for a portion of such embedment.

(c) Stirrups shall be anchored at both ends by one of the following methods or by a combination thereof:—

(1) Rigid attachment, as by welding, to the main

longitudinal reinforcement. The capacity of this anchorage is limited to that of the attachment.

(2) Bending around and closely in contact with a bar of the main longitudinal reinforcement in the form of a U-stirrup or a hook. The capacity of this anchorage may be taken as sixteen thousand pounds per square inch in the stirrup.

(3) A hook placed as close to the upper or lower surface of the beam as the requirement for fire and rust protection will allow. The capacity of this anchorage shall be ten thousand pounds per square inch in the stirrup plus the stress developed by bond between mid-height of the effective depth of the beam and the beginning of bending of the hook.

(4) A length of embedment in the upper or lower half of the effective depth of the beam, whether straight or curved. The capacity of this anchorage shall be limited to the stress developed by bond on the embedded length. Anchorage of this type shall not be used on stirrups where the unit shear exceeds (0.06  $f'_c$ ).

**SECTION 2647. *Slenderness of Reinforced Concrete Beams.***—The clear distance between lateral supports of a beam shall not exceed thirty-two times the width of the compression area of the cross-section.

**SECTION 2648. *T-Beams of Reinforced Concrete.***  
—(a) In T-beam construction the slab shall be built integrally with the beam. In the design of symmetrical T-beams the overhanging flange width on either side of the web shall not exceed one tenth the span, nor eight times the thickness of the slab nor one half the clear distance to the next beam.

(b) For beams having a flange on one side only, the effective overhanging flange width shall not exceed one twelfth of the span length nor six times the thickness of the slab nor one half the clear distance to the next beam.

(c) Where the principal reinforcement in a slab which serves as the flange of a T-beam (not a rib in ribbed floors) is parallel to the beam, transverse reinforcement shall be provided in the top of the flange. The spacing of the bars shall not exceed five times the thickness of the flange, or eighteen inches.

(d) Isolated beams in which the T-form is used only for the purpose of providing additional compression area, shall have a flange thickness not less than one half, and a total flange width not more than four times, the web thickness.

SECTION 2649. *Compression Reinforcement in Beams and Girders.* — Steel reinforcing bars in compression in girders and beams shall be thoroughly anchored against buckling by ties or stirrups not less than one quarter inch in diameter spaced not further apart in the region where compression steel is required than twelve times the diameter of the bars, or by equivalent lateral support.

SECTION 2650. *Structural Steel Beams Encased in Concrete.* — (a) Structural steel beams which are fireproofed by being wholly encased in the concrete of a reinforced concrete floor or roof may be designed for bending as composite beams, the two materials assumed to act elastically together, the concrete not to act in tension, the stresses in the respective materials not to exceed those allowed by this code.

(b) Without such an elastic analysis of stresses, a

steel beam which is fireproofed by being wholly encased in concrete having a strength of at least two thousand pounds per square inch, which is part of a reinforced concrete floor or roof, the slab of which forms an effective compression flange as provided in section twenty-six hundred and forty-eight equal in area of cross-section to at least half that of the encasing concrete, may be considered to have its resistance to bending increased fifteen per cent.

*SECTION 2651. Shrinkage and Temperature Reinforcement.* — (a) Reinforcement for shrinkage and temperature stresses shall be provided in floor and roof slabs perpendicular to the reinforcement for bending where this runs in one direction only. Such reinforcement shall have an area of cross-section not less than two one thousandths times the area of the concrete and bars shall be spaced not more than five times the slab thickness nor more than eighteen inches.

(b) In reinforced concrete spandrel beams and parapet walls shrinkage reinforcement shall be provided, in amount not less than one half of one per cent, in addition to the reinforcement for bending. Such reinforcement shall be continuous and rods shall be spliced by lapping or otherwise, except at expansion joints.

(c) Consideration shall be given to the stresses due to expansion and shrinkage in buildings more than two hundred feet long and provision shall be made satisfactory to the commissioner for avoiding excessive stress. In buildings longer than four hundred feet expansion joints shall be provided not more than three hundred feet apart. Such joints

shall be constructed with at least one inch opening and shall allow for expansion of each section of building not less than one half inch for every one hundred feet of its length.

**SECTION 2652. Concentrated Loads on Concrete Slabs.**—(a) For computation of stresses due to bending and shear, concentrated loads on one-way slabs may be considered as evenly distributed over an effective width at right angles to the direction of the span as follows:—

Solid concrete construction . . .	$w + 0.8 s$
Combination floor construction . . .	$w + 0.6 s$
Ribbed floor construction . . .	$w + 0.4 s$ but not more than $w +$ twice the rib spacing

where (w) is the actual width of the concentration and (s) is the distance from the nearer support to the center of the concentration. For concentrations at mid-span or for loads such as partitions which are concentrated laterally but distributed longitudinally to the span, (s) shall be taken as equal to half the span.

(b) If adequate bridging is provided to distribute concentrations among adjacent ribs, the effective width for combination and ribbed slabs may be taken as for solid slabs, but in the case of ribbed slabs, unless the bridging has approximately the same spacing as the ribs, not more than three adjacent ribs shall be assumed to share the load.

**SECTION 2653. Concrete Ribbed and Combination Slabs.**—(a) Ribbed floor construction consists of concrete ribs, running in one or two directions and topping placed monolithically with the ribs, not

over twenty inches apart between faces. The ribs shall be straight and of a width not less than four inches nor less than one third the depth. The topping shall be of sufficient strength to transmit loads coming upon it to the adjacent ribs and shall be not less than two inches thick. Ribbed slabs shall be reinforced at right angles to the ribs with a minimum of forty-nine one thousandths square inch of reinforcing steel per foot and in slabs on which the prescribed live load does not exceed fifty pounds per square foot, no additional reinforcement shall be required.

(b) Combination floor construction consists of concrete ribs running in one or two directions, with masonry fillers, filling the entire space between ribs, and either with or without a monolithic concrete topping over the ribs. Each masonry filler shall have contact with ribs on two opposite sides. Ribs shall be not over twenty inches apart between faces, shall be straight and of a width not less than four inches nor less than one third the depth. Either the fillers or the topping over them, or the combination of the two shall be of sufficient strength to transmit any load coming on them to the adjacent ribs. If a monolithic topping is used, it shall be not less than one inch thick.

(c) If structural fillers as specified in paragraph (e) are used, then, and not otherwise, certain portions of them may be included with the concrete in calculations of resistance to shear and bending, but the amount included shall nowhere exceed the actual thickness of the portion of the filler nor one and one half inches. In one-way construction the webs of structural fillers which are in contact with the concrete ribs and where there is a topping the web in

contact therewith may be included with the concrete in calculations of resistance to shear and bending. In construction in which the ribs run in both directions and at approximately the same distance on centers, and whether designed as one-way or two-way slabs, the webs in contact with the concrete ribs may be included in calculations of resistance to shear and bending and the top and bottom webs may be included in calculations of resistance to bending.

(d) The maximum stress in both the concrete and the filler shall not exceed that allowed in the weaker of the two materials.

(e) A structural filler, for the purpose of this section, shall have an ultimate strength in compression, on its net section, when tested on end at the age of twenty-eight days, of two thousand pounds per square inch. If structural clay tiles are used as fillers they shall at least equal those classified as Grade B in Part 24 of this code. Gypsum tile shall not be used as a structural filler.

(f) The unit extreme compressive fiber stress in the filler tile shall not exceed four tenths of its ultimate unit compressive strength, determined for the net section from an average of three fillers tested on end at an age of twenty-eight days. The unit stress allowed in shear computations shall not exceed one quarter of the average ultimate strength in shear of the joint between the ribs and the filler blocks.

(g) Where the topping contains conduits or pipes, the thickness shall not be less than one inch plus the total overall depth of such conduits or pipes at any point. Such conduits or pipes shall be so located as not to impair the strength of the construction.

(h) Shrinkage reinforcement shall be provided in

the slab as required in section twenty-six hundred and fifty-one.

(i) Neither paper, wood, nor roofing material shall be used between or at the ends of structural hollow masonry fillers included in calculations of resistance to shear or bending to prevent concrete from flowing into the interstices thereof, nor any other material that would impair the bond between the end of the filler and the concrete, but this shall not prevent the use of such materials when inserted but not projecting from the openings of the fillers nor the use of the same material that is permitted for the fillers themselves. If concrete is allowed to penetrate the interstices of hollow masonry fillers, the weight thereof shall be included in the dead load to be supported. The webs of structural filler units whose ends are thus in contact with the concrete may be included in calculations of resistance to bending.

**SECTION 2654. *Two-Way Slabs of Reinforced Concrete.*** — (a) Concrete slabs, either solid, ribbed or combination slabs, supported on four sides by beams, girders or walls, and reinforced to span in two directions shall be designed in accordance with the provisions of this section.

(b) The slab shall be regarded as consisting of a series of adjacent strips of unit width spanning in each direction. In computations for shear and diagonal tension, bond, and for the loading of supporting members, each strip, spanning in either the longer or the shorter direction, shall be assumed to carry and transmit to its support a total load (W), represented by the expression:

$$W = \frac{1}{2} C \cdot r w L = \frac{1}{2} C_o w L_1$$

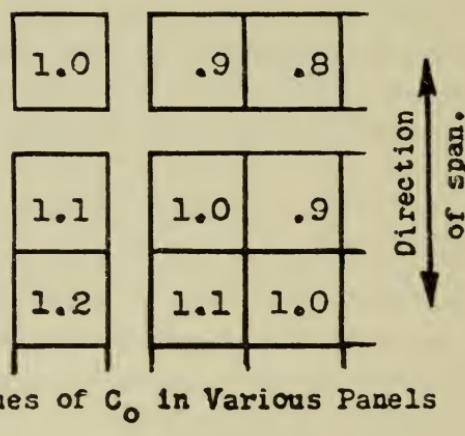
in which (w) is the load per unit area of the slab.

(L) is the span of the strip.

( $L_1$ ) is the width of the panel transverse to the span.

(r) is the ratio of  $L_1$  to L.

( $C_0$ ) is a coefficient dependent on the position of the panel relative to adjacent panels continuous with it at its ends and sides, as indicated on the accompanying diagram. Full restraint at an end support, as defined in section twenty-six hundred and thirty-six, shall be considered equivalent to continuity in determining ( $C_0$ ).



Values of  $C_0$  in Various Panels

(c) The positive bending moment for a strip of unit width in the middle half of the panel, spanning in either direction, shall be assumed as given by the following formula:—

$$M = \frac{3}{10} C_1 C_0 r^2 w L^2 = \frac{3}{10} C_1 C_0 w L_1^2$$

in which ( $C_1$ ) is a coefficient for bending determined in accordance with the conditions of restraint at end supports of the strips as provided in section twenty-

six hundred and thirty-five or section twenty-six hundred and thirty-six.

(d) Negative moments at and adjacent to supports between two panels shall be determined by the formula given in paragraph (c) for positive moment taking ( $C_1$ ) as the coefficient for negative moment determined according to section twenty-six hundred and thirty-five or section twenty-six hundred and thirty-six, and in case the conditions of continuity in the two panels are different, taking the mean value of ( $C_o$ ).

(e) The positive bending in strips of unit width in the outer quarters of the panel may be assumed to be three quarters that of the strips of the middle half.

(f) Lines of inflection in a two-way panel shall be assumed at a distance of one fourth of its shorter span from supports over which the slab is continuous.

**SECTION 2655. *Limitations upon Reinforced Concrete Flat Slabs.*** — (a) The term "flat slabs" as used herein refers to concrete slabs with reinforcing bars in two or more directions, whose interior supports are columns or the like, generally without beams.

(b) The methods of stress computation herein specified apply to a series of slabs of approximately uniform size extending at least three panels in each direction and in which the length of panel does not exceed one and one half times its width. Flat slabs of other arrangement shall be proportioned to have at least equal carrying capacity and degree of safety according to established principles of mechanics.

(c) Flat slabs with paneled ceiling or with dropped panels may be proportioned by the methods herein specified provided the dropped panel shall have a length or diameter in each rectangular direction not less than one third the panel length in that direction,

and the thickness of the thicker portion of the slab shall not exceed one and one half times that of the remainder. In the ceilings of flat slabs, concrete between rods in tensile regions and in compressive regions where it can be spared may be displaced by permanent or removable fillers, provided allowable stresses are not exceeded in the concrete which remains and provided the tensile stress in the reinforcing rods in that region shall not exceed eight ninths the stress allowed in the reinforcement of solid concrete slabs. Compression concrete above such fillers shall have a thickness not less than two inches, and the construction shall safely support any concentration of load that may come upon it. The term "slab thickness" used in connection with such construction shall refer to the total thickness of the structural concrete.

(d) Column capitals, if of concrete, shall be of the mixture required for the column up to a level where the area of a horizontal section is fifty per cent more than the gross area of the shaft of the column. In dimensioning the concrete capital for design purposes, no portion of the capital shall be considered which lies outside the largest ninety-degree circular cone contained within its outlines. The diameter of the capital shall be measured for design purposes at the junction of the cone with the bottom of the slab or dropped panel.

(e) Column capitals of structural metal may be substituted for concrete capitals, whether contained within the thickness of the slab and dropped panel, or not, provided they meet the following requirements:—

(1) they shall have the same protection against fire required for reinforcement in similar exposures;

(2) they shall safely support the slab on the periphery of the capital without exceeding stresses allowed in this code for the kind of metal used;

(3) they shall provide support for the slab or dropped panel at a distance above the bottom thereof not substantially greater than the requirements for fire protection, and such support shall either be continuous along the periphery of the capital or with intervals not greater than three times the thickness of concrete slab, or slab and dropped panel;

(4) the capitals shall be so designed and arranged as to permit the proper placement of concrete in and about them without pockets or voids, and to provide for the transmission of load from columns above to columns below;

(5) the diameter of a metal column capital, for purposes of slab design, shall be taken as twice the distance from the center of the column to the center of bearing of slab or dropped panel on a continuous circumferential support, or twice the average distance to centers of bearing on radial or non-continuous supports, the unit bearing assumed as uniform and not in excess of the stress allowed by this code.

**SECTION 2656. Assumptions in Concrete Flat Slab Design.** — (a) A flat slab panel shall be considered as consisting of strips, parallel to sides of the panel, as follows: —

(1) A middle strip one half panel in width, symmetrical with respect to the panel center line.

(2) A column strip one half panel in width made up of two quarter-panel areas outside the middle strips.

(3) The strips shall be considered in each rectangular direction for the computation of bending moments.

(b) The critical sections for bending are referred to as the principal design sections and are located as follows:—

(1) Sections for negative bending shall be taken along the edges of the panel at ends of the strips, on center lines of columns, and around the periphery of the column capital.

(2) Sections for positive bending shall be taken at mid-length of the strips, on the center line of the panel.

**SECTION 2657. *Bending in Interior Flat Slab Panels.*** — (a) The numerical sum of the positive and negative bending moments in either rectangular direction of an interior panel, for the design of tensile reinforcement, shall be assumed as not less than —

$$M_0 = 0.09 WL \left(1 - \frac{2c}{3L}\right)^2 = M_{pc} + M_{pm} + M_{nc} + M_{nm}$$

where ( $M_{pc}$ ) is the positive moment at mid-span of the column strip.

( $M_{pm}$ ) is the positive moment at mid-span of the middle strip.

( $M_{nm}$ ) is the negative moment at one end of a middle strip.

( $M_{nc}$ ) is the negative moment at one end of the column strip.

(L) is the length of the strips between center lines of columns.

(c) is the diameter of the column capital, or top of column if there is no capital.

(W) is the total live and dead load on the panel assumed as uniformly distributed.

(b) The bending moments for the design of tensile reinforcement in the principal design sections shall be assumed to be those given in the following table, except that  $(M_{nc})$  may be  $(0.03 M_o)$  greater or smaller, and each of  $(M_{pc})$ ,  $(M_{pm})$  and  $(M_{nm})$  may be  $(0.01 M_o)$  greater or smaller provided that the sum remains not less than the value specified for  $(M_o)$ .

*Bending Moments in Flat Slabs for Tensile Reinforcement — Interior Panels Fully Continuous.*

MOMENT.	TWO-WAY REINFORCEMENT.		FOUR-WAY REINFORCEMENT.	
	Without Dropped Panel.	With Dropped Panel.	Without Dropped Panel.	With Dropped Panel.
$M_{pc}$	$0.22M_o$	$0.20M_o$	$0.20M_o$	$0.19M_o$
$M_{pm}$	$0.16M_o$	$0.15M_o$	$0.20M_o$	$0.19M_o$
$M_{nc}$	$0.46M_o$	$0.50M_o$	$0.50M_o$	$0.54M_o$
$M_{nm}$	$0.16M_o$	$0.15M_o$	$0.10M_o$	$0.08M_o$

(c) If a flat slab is supported at interior column points by supports less rigid than the columns specified in section twenty-six hundred and sixty-nine, paragraph (b), the positive bending in column and middle strips shall be increased twenty per cent above the tabular values.

SECTION 2658. *Spacing of Flat Slab Reinforcement.* — (a) Bands of rods in two-way systems of reinforcement shall be spread evenly over the width of the strips.

(b) Direct bands of rods in four-way systems shall have a width of about (0.4) times the panel width, diagonal bands (0.4) times the average panel widths, and the rods shall be spread evenly in the bands.

(c) The maximum spacing of rods shall not exceed three times the thickness of the slab.

SECTION 2659. *Thickness of Concrete Flat Slabs.* — (a) The thickness of a flat slab, and the size and thickness of the dropped panel shall be such that the compressive stress due to bending will not exceed that allowed for concrete on the principal design sections of any strip. The bending moments for which the compressive stress shall be computed shall be assumed to be four thirds those specified for the design of reinforcement.

(b) The width of section for computing compression in concrete due to negative bending at the column head shall be taken as the width of the dropped panel if any; otherwise, half the panel width. The width of other principal sections shall be taken as half the panel width.

(c) The thickness of the slab and the size and thickness of the dropped panel shall be such that shearing stresses computed as specified in section twenty-six hundred and forty-one shall not exceed the stress allowed.

(d) In no case, however, shall the slab thickness be less than one fortieth the length of the panel.

SECTION 2660. *Point of Inflection in Flat Slabs.* — (a) In a middle strip the point of inflection for slabs without dropped panels shall be assumed at a line (0.33L) distant from the center of the span and for slabs with dropped panels (0.3L) distant from the center of the span.

(b) In a column strip, the point of inflection for slabs without dropped panels shall be at a line 0.33

(L-c) distant from the center of the panel and 0.3 (L-c) for slabs with dropped panel.

**SECTION 2661. *Arrangement of Flat Slab Reinforcement at Column Heads.***— Reinforcement shall be provided not only for the moments at principal design sections but also for moments at intermediate sections. Steel of the full area required for negative moment at the column head shall be continued in the same plane close to the upper surface of the slab to the edge of the dropped panel, and not less than a distance (0.2L) from the center line of the column. Lapped splices shall not be permitted at or near regions of maximum stress except as described in section twenty-six hundred and twenty-six.

**SECTION 2662. *Arrangement of Flat Slab Reinforcement — Two-way System.***— (a) In column strips at least four tenths of the area of steel required at the principal design section for positive moment in the strip shall be in bars of such length and so placed as to reinforce the sections for negative moment at the adjacent column heads. These bars, and other bars for negative reinforcement shall extend into the adjacent panel to a point at least (0.05L) beyond the point of inflection. Not less than one third of the bars used for positive reinforcement in the column strip shall be straight and extend into the dropped panel at least twenty diameters of the bar, but not less than twelve inches; or if no dropped panel is used, shall extend to within (0.125L) of the center line of the columns. The remainder of the bars for positive reinforcement in the column strip shall extend at least (0.33L) on either side of the center line of panel. Not less than one fourth in area of the bars

for negative reinforcement of each column strip shall lie directly over the column capital and not less than one half within the width of the dropped panel, if any.

(b) In the middle strip at least one half of the bars for positive moment shall be bent up for negative moment and extend over the bands of the column strips at both sides of the panel to a point at least  $(0.25L)$  beyond the center line of columns. The location of the bends shall be such that for a distance  $(0.15L)$  for slabs with dropped panels, and  $(0.125L)$  for slabs without dropped panels, on each side of the center line of columns, the full reinforcement required for negative moment will be provided in the top face of the slab. The full reinforcement for positive moment in the middle strip shall extend in the bottom face of the slab to a point at least  $(0.25L)$  on either side of the panel center line, and at least one half of it shall extend to points  $(0.325L)$  on either side of the panel center line for slabs with dropped panels, and  $(0.35L)$  for slabs without dropped panels.

SECTION 2663. *Arrangement of Flat Slab Reinforcement — Four-way System.* — (a) Provisions governing the placing of steel in column strips in two-way systems apply as well to the direct bands in four-way systems.

(b) In diagonal bands, at least four tenths of the area of steel required at the section for positive moment shall be in bars of such length and so placed as to reinforce the negative moment section at the two diagonally opposite column heads. These bars and other bars for negative reinforcement, if any, shall extend into the adjoining panel to points at least  $(0.4L)$  beyond a line drawn through the column

center perpendicular to the direction of the band. The straight bars for positive moment in the diagonal bands shall not be shorter than the length of panel center to center of columns.

(c) For negative moment in the middle strip, the required steel shall extend not less than (0.25L) on either side of the column center line.

**SECTION 2664. *Flat Slab Reinforcement Other than Two-way or Four-way.*** — Arrangement of reinforcement other than two-way or four-way shall provide reinforcing at the principal design sections and at intermediate sections equivalent to that specified above.

**SECTION 2665. *Discontinuous Flat Slab Panels.*** — (a) In panels adjacent to an exterior wall and other panels where the slab is discontinuous on one or two of its edges, the bending on principal design sections parallel to a discontinuous edge shall be assumed at values not less than specified in this section, depending upon the degree of restraint in bending furnished by the support at such discontinuous edge.

(b) The numerical sum of the positive bending moment at mid-span and the average of the negative bending moments at the discontinuous edge and at the first interior supports for a full panel width, for the design of tensile reinforcement, shall be assumed as not less than

$$M_o = 0.10 WL \left(1 - \frac{c + a}{3L}\right)^2$$

in which (L) is the span center to center of columns, walls or other supports; (c) is the diameter of the interior column capital and (a) is the thickness of

the exterior support in the direction of the span. A bracket on the inner face of an exterior column shall be ignored in determining the value of (a).

(c) The bending moments for the design of tensile reinforcement in the principal design sections of the several strips shall be assumed, within the range of allowable variation specified in paragraph (b) of section twenty-six hundred and fifty-seven, as follows: —

*Bending Moment for Tensile Reinforcement in Wall Panels of Flat Slabs.*

MOMENT.	TWO-WAY REINFORCEMENT.		FOUR-WAY REINFORCEMENT.	
	Without Dropped Panel.	With Dropped Panel.	Without Dropped Panel.	With Dropped Panel.

NEGLIGIBLE RESTRAINT AT DISCONTINUOUS EDGE.

$M_{pc}$	$0.32M_o$	$0.31M_o$	$0.30M_o$	$0.29M_o$
$M_{pm}$	$0.26M_o$	$0.25M_o$	$0.30M_o$	$0.29M_o$
$M_{nc}$ (ext.)	$0.05M_o$	$0.05M_o$	$0.05M_o$	$0.05M_o$
$M_{nm}$ (ext.)	$0.05M_o$	$0.05M_o$	$0.05M_o$	$0.05M_o$
$M_{nc}$ (int.)	$0.55M_o$	$0.60M_o$	$0.60M_o$	$0.65M_o$
$M_{nm}$ (int.)	$0.19M_o$	$0.18M_o$	$0.10M_o$	$0.09M_o$

MODERATE RESTRAINT AT DISCONTINUOUS EDGE.

$M_{pc}$	$0.29M_o$	$0.27M_o$	$0.26M_o$	$0.25M_o$
$M_{pm}$	$0.23M_o$	$0.22M_o$	$0.26M_o$	$0.25M_o$
$M_{nc}$ (ext.)	$0.22M_o$	$0.23M_o$	$0.25M_o$	$0.26M_o$
$M_{nm}$ (ext.)	$0.08M_o$	$0.08M_o$	$0.06M_o$	$0.06M_o$
$M_{nc}$ (int.)	$0.50M_o$	$0.55M_o$	$0.55M_o$	$0.60M_o$
$M_{nm}$ (int.)	$0.18M_o$	$0.16M_o$	$0.10M_o$	$0.08M_o$

FULL RESTRAINT AT DISCONTINUOUS EDGE.

$M_{pc}$	$0.25M_o$	$0.22M_o$	$0.22M_o$	$0.21M_o$
$M_{pm}$	$0.20M_o$	$0.20M_o$	$0.22M_o$	$0.21M_o$
$M_{nc}$ (ext.)	$0.38M_o$	$0.41M_o$	$0.46M_o$	$0.48M_o$
$M_{nm}$ (ext.)	$0.10M_o$	$0.10M_o$	$0.06M_o$	$0.06M_o$
$M_{nc}$ (int.)	$0.46M_o$	$0.50M_o$	$0.50M_o$	$0.54M_o$
$M_{nm}$ (int.)	$0.16M_o$	$0.15M_o$	$0.10M_o$	$0.08M_o$

(d) If restraint at a discontinuous edge is furnished by a wall, the negative bending at the exterior support may be more nearly evenly distributed between column and middle strips. If the supports at interior column points are less rigid than the column specified in section twenty-six hundred and sixty-nine the positive bending in column and middle strips shall be increased twenty per cent above the tabular values.

(e) Negligible restraint in bending at the discontinuous edge of a flat slab panel shall be considered to be furnished by a supporting wall of masonry or a row of masonry piers or by any support that does not assure as great restraint as that specified as moderate.

(f) Moderate restraint shall be considered to be furnished by a wall of reinforced concrete or by a row of reinforced concrete columns or of steel columns encased in concrete when the slab acts integrally with the support and when the support is not sufficiently rigid to afford full restraint.

(g) Full restraint shall be assumed where the discontinuous edge of a flat slab is supported by a reinforced concrete wall or row of columns with which it acts integrally and when the ratio  $(\frac{I}{L})$  for the slab is less than the sum of the ratios  $(\frac{I}{h})$  for the walls or columns, respectively, above and below the slab. For the purpose of this section (I) is the moment of inertia of the slab, wall or column calculated for the gross area of the concrete and neglecting the reinforcement.

(h) Except in the case of negligible restraint where

precautions are taken to avoid restraint, the bending incidental to the restraint shall be transmitted to the supports, with or without the aid of brackets, in such manner that the stresses specified in this code for the materials used shall not be exceeded. The supports shall be made capable of resisting the bending so transmitted in addition to their other loads and forces without excessive stress. The bending moments transmitted shall be assumed to be four thirds those specified in this section for design of the tensile reinforcement of the slab.

(i) The reinforcement for positive bending perpendicular to the discontinuous edge shall extend to this edge and have an embedment of at least six inches in spandrel beams, walls or columns. Reinforcement for negative bending shall be bent or hooked at spandrel beams, walls or columns to provide adequate anchorage. The length and placement of other reinforcement in wall panels shall be adapted from the requirements of sections twenty-six hundred and sixty-one, twenty-six hundred and sixty-two and twenty-six hundred and sixty-three having in view the changed location of the points of inflection.

(j) The half column strip parallel and adjacent to a marginal beam having a depth not greater than one and one half times the slab thickness, or parallel and adjacent to a discontinuous edge without marginal beam, shall be designed to resist at least one half the moments specified for a full interior column strip. The half column strip parallel and adjacent to a marginal beam having a depth greater than one and one half times the thickness of the slab, shall be designed to resist at least one fourth the moments specified for a full column strip.

(k) If a flat slab is supported at a discontinuous edge by a row of columns having brackets extending from the side of the column in a direction parallel to the discontinuous edge which are equivalent to column capitals, the value of (c) parallel to the discontinuous edge shall be the total width of the capital or brackets. If such columns are without brackets the value of (c) parallel to the discontinuous edge shall be taken as the width of the column plus twice the difference between the depth of the marginal beam, if any, and the depth of the slab.

(l) Dropped panels at wall columns may be omitted, provided the allowed unit stresses are not exceeded.

(m) The provisions of section twenty-six hundred and fifty-nine shall apply to wall panels.

#### SECTION 2666. *Marginal Beams in Flat Slabs.* —

(a) In panels having a marginal beam on one edge or on each of two adjacent edges, whether or not the slab is there discontinuous, the beam shall be designed to carry at least the load superimposed directly upon it, exclusive of the panel load. A marginal beam which has a depth greater than one and one half times the slab thickness, shall be designed to support, in addition to the load superimposed directly upon it, a uniformly distributed load equal to at least one fourth the total live and dead load for which the adjacent panel or panels are designed.

(b) Where there is a beam or a bearing wall at the center line of columns in the interior portion of a continuous flat slab, the negative moment at the beam or wall line in the middle strip perpendicular to the beam or wall shall be taken as thirty per cent

greater than the negative moment specified in section twenty-six hundred and fifty-seven or section twenty-six hundred and sixty-five for a middle strip. The half column strip adjacent and parallel to and lying on either side of the beam or wall shall be designed to resist moments, at least one fourth of those specified in section twenty-six hundred and fifty-seven or section twenty-six hundred and sixty-five for a column strip. The beam or wall in such cases shall be designed to carry a uniformly distributed load equal to one fourth of the panel loads on both sides in addition to the loads directly imposed upon it.

SECTION 2667. *Openings in Flat Slabs.* — (a) Openings of any size may be formed in the area common to two intersecting middle strips, provided the total positive and total negative moments as specified in section twenty-six hundred and fifty-seven or section twenty-six hundred and sixty-five are effectually resisted when these total positive and total negative moments are redistributed between the remaining principal design sections to meet the conditions.

(b) In an area common to two column strips, not more than one opening shall be allowed and the greatest dimension of such an opening shall not exceed  $(0.05L)$ .

(c) In an area common to one column strip and one middle strip, openings shall not interrupt more than one quarter of the bars in either strip when evenly spaced and the equivalent of the bars so interrupted shall be provided by extra reinforcement on both sides of the opening.

(d) An opening larger than allowed by this section shall be completely framed with beams to carry the loads to the columns.

**SECTION 2668. *Construction Joints in Flat Slabs.***

— Construction joints in flat slabs shall occur preferably midway between columns. Where such joints occur, steel reinforcing shall be provided perpendicular to the joints in addition to the reinforcement required for bending, of cross-sectional area equal to one third that required for bending at the joint. Steel rods so provided shall be spaced not over three times the slab thickness, shall be fully anchored for the allowed tensile stress by embedment each side of the joint, and shall be placed in the same plane with the reinforcement provided for bending in each strip.

**SECTION 2669. *Limiting Dimensions of Concrete Columns.*** — (a) Unless designed as long columns under the provision of section twenty-six hundred and seventy-three, reinforced concrete columns shall not be longer than twelve times the least lateral dimension. Struts shall be designed as columns.

(b) In flat slab construction, except as otherwise provided in paragraph (c) of section twenty-six hundred and fifty-seven and paragraph (d) of section twenty-six hundred and sixty-five, the least dimension of a column supporting a floor shall be not less than one fifteenth the average center to center spacing nor less than sixteen inches; and that of a column supporting only a roof not less than one twentieth the average spacing nor less than fourteen inches.

**SECTION 2670. *Unsupported Length of Concrete Columns.*** — (a) The unsupported length of a column shall be taken as the clear distance between lateral supports. When the lateral support consists of a floor or roof with beams of different depths, the height of the column to the bottom of the deepest beam in a given direction shall be used with the thickness of the column in that direction in computing the slenderness ratio. When free-standing ties or struts are provided for lateral support, they shall be adequate to prevent the column from bending, and the clear distance between supports in any direction shall be used with the thickness of the column in that direction in computing the slenderness ratio.

(b) Concrete column capitals in flat slab construction, and brackets the full width of supported beams which are inclined at least forty-five degrees to the column, may be considered lateral supports.

**SECTION 2671. *Design of Concrete Columns with Spiral Reinforcement.*** — (a) The axial load on columns reinforced with longitudinal bars and closely spaced spirals enclosing a circular core shall not be greater than that determined by the formula

$$P = A_g (0.25 f'_c + 18\ 000p)$$

For the purpose of this section the gross area of the concrete ( $A_g$ ) shall be assumed not to exceed the area of a circle of which the diameter ( $D$ ) is three inches larger than the outside diameter of the spiral.

(b) The longitudinal reinforcement shall consist of at least six bars not less than one half inch in diameter and having an effective cross-sectional area not less than one per cent nor more than six per cent

of the gross concrete area, which shall be placed inside and as close as possible to the spiral reinforcement.

(c) Spiral reinforcement shall consist of evenly spaced continuous spirals held firmly in place and true to line by at least three vertical spacer bars. The outside diameter of spirals shall be maintained constant and the ends of the spiral wire shall be anchored. Spiral wire may be spliced by lapping one third the circumference of the spiral and hooking the ends, or by welding. The spacing of the spirals shall not exceed one sixth the diameter of the core nor three inches. The volume of the spiral reinforcement shall not be less than one per cent of the gross volume of the concrete, as defined in paragraph (a) of this section, in cubic inches per inch length of column, nor less than

$$\frac{D f'_c}{20\,000}$$

in which (D) is the gross diameter of the column in inches.

(d) Spiral and longitudinal reinforcement shall be protected by a covering of concrete cast monolithic with the core not less than one and one half inches thick.

(e) In columns supporting a beam-and-slab floor or roof, the spiral reinforcement shall extend from the floor below at least to one and one half inches above the bottom of the lowest beam of the floor or roof above, which frames into the column.

(f) In columns supporting a flat slab floor or roof the spiral reinforcement shall extend from the floor at least to mid-height of the concrete column capital above.

SECTION 2672. *Design of Concrete Columns or Struts with Lateral Ties.* — (a) The axial load on columns or struts reinforced with longitudinal bars and separate lateral ties shall not be greater than that determined by the formula —

$$P = A_g (0.20 f'_c + 14,400 p)$$

(b) The ratio of longitudinal reinforcement shall not be less than one per cent nor shall the ratio considered in the calculations be more than four per cent of the total area of the column. The longitudinal reinforcement shall consist of not less than four bars placed so as to have a clear distance from the face of the column of not more than three inches and not less than one and one half inches.

(c) Lateral ties shall be at least one quarter inch in diameter. They shall be spaced not more than twelve inches apart. In columns of rectangular section, containing more than four longitudinal bars cross ties shall be arranged to afford support to all bars.

SECTION 2673. *Long Concrete Columns.* — (a) The axial load on columns which are longer than twelve times the least dimension shall not be greater than —

$$P' = P \left( 1.50 - \frac{h}{96R} \right)$$

for round columns, or —

$$P' = P \left( 1.50 - \frac{h}{70R} \right)$$

for rectangular columns.

(b) The radius of gyration of a column shall be computed from the concrete area and the transformed

area of the longitudinal steel (the actual area of steel multiplied by  $(n)$ ).

SECTION 2674. *Bending in Concrete Columns.* —

(a) The bending which may be found to exist in columns under the provisions of sections twenty-six hundred and thirty-one, twenty-six hundred and thirty-five, twenty-six hundred and thirty-six and twenty-six hundred and sixty-five, or due to eccentric loads or to soil pressure or other lateral forces (but not the bending provided for in section twenty-six hundred and seventy-three) shall be provided for in the design of the columns. Bending due to the restraint of floors or roofs may be distributed between the column below and that above (if any) in proportion to the value of their ratios  $(I/h)$ .

(b) One and one half times the unit compressive stress in the concrete due to axial load and the extreme compressive stress due to computed bending, when added, shall not exceed the allowable unit stress in flexure as specified in section twenty-six hundred and twenty-nine.

(c) This allowable stress is subject to increase in accordance with section twenty-six hundred and thirty-one under wind loads, but is not subject to reduction for slenderness. All columns must, however, support their axial loads without exceeding the stresses allowed therefor, subject to reduction for slenderness in accordance with section twenty-six hundred and seventy-three.

SECTION 2675. *Composite Columns.* — (a) The axial load on composite columns, in which a structural steel or cast iron column is encased in the con-

crete core of a spirally reinforced concrete column with not less than two nor more than four per cent of longitudinal reinforcement in the form of bars arranged at the periphery of the core, and not less than one per cent of spiral reinforcement meeting the requirements for spirals of section twenty-six hundred and seventy-one, shall not exceed the allowable load of the metal column plus that of the surrounding concrete column. The allowable load of the cast iron or steel column shall be that specified for such columns in Part 28 when not encased. The allowable load supported by the concrete shall be that specified for columns with spiral reinforcement in section twenty-six hundred and seventy-one.

(b) The diameter of a cast iron column so encased shall not exceed one half the diameter of the core nor shall its total area exceed twelve per cent of the core area (area included within the outer circumference of the spiral reinforcement). The dimensions of a structural steel section so encased shall be such as to provide at least three inches between the spiral and the corners of the section and its area shall not exceed twelve per cent of the core area. Metal columns shall be accurately milled at splices and positive provision shall be made for the alignment of one column above another. Bond between the metal column and the surrounding concrete shall not be relied upon to transmit loads to and from the metal column.

SECTION 2676. *Combination Columns.* — (a) The axial load on combination columns, in which structural steel columns of rolled or built up section wrapped with No. 8 gage wire spaced four inches on

centers or its equivalent are encased in concrete not less than two inches thick over all of the metal except rivet heads and connections, shall not exceed

$$\left(1 + \frac{A_g}{100 A_s}\right)$$
 times the allowable load for the unencased steel column as specified in Part 28.

(b) The concrete shall be at least equal in quality to two-thousand-pound concrete as specified in section twenty-six hundred and ten.

**SECTION 2677. *Monolithic Concrete Walls.*** — (a) Reinforced concrete walls shall have at least the thickness specified in Part 14. Reinforced concrete walls shall be reinforced in two directions at right angles by steel reinforcement having an effective area in each direction of not less than (0.0025) times the cross-sectional area of the concrete. In walls less than six inches thick the reinforcement may be placed at mid-thickness of the wall unless calculated bending requires it to be placed near one face. In walls six inches or more in thickness, not less than half the steel required by this paragraph shall be placed as close to each face of the wall as requirements for fire and rust protection will allow. Such steel reinforcement shall be in the form of reinforcing bars not less than three-eighths inch in diameter and spaced not over eighteen inches apart or of approved wire mesh.

(b) The capacity of a reinforced concrete wall to support a vertical load shall be computed in the same manner as specified in sections twenty-six hundred and seventy-two, twenty-six hundred and seventy-three and twenty-six hundred and seventy-four for columns with lateral ties. The vertical rein-

forcement shall not be assumed to contribute to the capacity of the wall unless it conforms to the requirements for longitudinal reinforcement in columns and is stayed by lateral ties perpendicular to the wall.

(c) Non-bearing retaining walls may be designed as slabs.

**SECTION 2678. *Sloped or Stepped Concrete Footings.*** — (a) Footings may have sloped or stepped tops provided that the thickness of the footing above the reinforcement shall not be less than six inches for footings on soil, nor less than nine inches for footings on piles.

(b) Concrete in reinforced footings shall be proportioned for a strength of at least eighteen hundred pounds per square inch.

**SECTION 2679. *Bending in Concrete Footings.*** — (a) The critical section for bending in a concrete footing which supports a concrete column or pedestal, shall be considered to be at the face of the column or pedestal. Where a steel or cast iron column base rests on a footing, moments in the footing shall be considered at the middle and at the edges of the base. The loads shall be considered as uniformly distributed over the column, pedestal or base. In the case of a round or polygonal column or base, its face for the purposes of this section shall be considered to be at the side of a concentric square of equal area.

(b) The bending moment at a critical section shall be computed from all the forces acting on the footing on one side of the section (excluding the weight of the footing), and for footings resting upon soil the

bending moment may be taken as three quarters of the moment obtained by assuming the soil pressure to act only vertically and with uniform intensity.

(c) Shear in footings shall be computed as specified in section twenty-six hundred and forty-two.

**SECTION 2680. *Bearing on Concrete Footings.* —**

(a) The unit compressive or bearing stress on top of a pedestal or footing directly under the column or base shall be not greater than that determined by the formula

$$\frac{f'_c}{16} (3 + \frac{A}{A'})$$

nor greater than  $(0.375 f'_c)$ , unless the pedestal or footing is reinforced laterally as provided in paragraph (b).

(b) When lateral reinforcement in the form of a spiral or hoops is provided in the pedestal or footing the unit stress in bearing for the core area may be increased to  $(1+2.5 np')$  times that allowed for plain concrete, but no area outside the outer face of the spiral or hoops shall be considered.

(c) The unit compressive stress on the gross area of the pier, pedestal or footing shall not exceed  $0.25 f'_c$ .

**SECTION 2681. *Concrete Pedestals without Reinforcement.* —** (a) The compressive unit stress on the gross area of a concentrically loaded pedestal or pedestal footing shall not exceed  $0.25 f'_c$ .

(b) The depth of a pedestal footing shall not be greater than three times its least width and the projection on any side from the face of the supported member shall not be greater than one half of the

depth for a rectangular footing and fifty-eight one hundredths of the depth for a circular footing. The depth of a pedestal whose sides are sloped or stepped shall not exceed three times the least width or diameter of the section midway between the top and the bottom. A pedestal footing supported directly on piles shall have a mat of reinforcing bars having a cross-sectional area not less than two tenths of a square inch per foot of width in each direction, placed two inches above the top of the piles.

## PART 27.

### REINFORCED GYPSUM CONCRETE.

#### SECTION

- 2701 — Design of Reinforced Gypsum Concrete.
- 2702 — Approval of Gypsum Concrete Products.
- 2703 — Materials of Gypsum Concrete.
- 2704 — Strength of Gypsum Concrete.
- 2705 — Modulus of Elasticity of Gypsum Concrete.
- 2706 — Allowable Stresses in Gypsum Concrete.
- 2707 — Poured-in-Place Gypsum Concrete.
- 2708 — Precast Gypsum Concrete.

**SECTION 2701. *Design of Reinforced Gypsum Concrete.*** — (a) Reinforced gypsum concrete shall be designed by methods admitting of rational analysis according to established principles of mechanics, supplemented by the assumptions herein specified, to support the loads and withstand the forces to which it is subject without exceeding the stresses allowed in this chapter for the materials thereof. The general assumptions and principles specified for reinforced concrete in Part 26 shall also apply to reinforced gypsum concrete in so far as they are pertinent.

(b) Reinforced gypsum concrete may be used for

the floors and roofs of buildings and other construction for which it is suitable, but shall not be used where exposed to moisture or to the weather, or for the floors of garages, or other floors subject to heavy moving or vibrating loads, or floors supporting a live load in excess of one hundred and twenty-five pounds per square foot.

**SECTION 2702. *Approval of Gypsum Concrete Products.*** — (a) Precast gypsum concrete units shall not be used structurally in floors or roofs until the manufacturer thereof has submitted satisfactory evidence of their quality and the commissioner has given his approval. Approval shall be conditioned upon such requirements as to design, materials, methods of manufacture, erection and support as the commissioner shall determine.

(b) An applicant for a permit involving the use of gypsum concrete cast in place shall have a competent inspector satisfactory to the commissioner at all times on the work when gypsum concrete is being mixed or deposited.

(c) The commissioner may require reasonable tests from time to time of gypsum concrete units or of the materials of gypsum concrete construction to determine their quality and whether they conform to the requirements of this chapter.

**SECTION 2703. *Materials of Gypsum Concrete.*** — (a) The term gypsum as used in this chapter shall mean calcined gypsum. Gypsum used in gypsum concrete shall conform to Specifications for Calcined Gypsum and Specifications for Gypsum of the American Society for Testing Materials.

(b) Gypsum concrete shall consist of a mixture of gypsum and water, with or without wood chips, fiber or other approved aggregate, which, when hard, makes a satisfactory building material.

(c) Precast gypsum concrete shall contain not more than three per cent and cast-in-place gypsum concrete not more than twelve and one half per cent of wood chips, shavings, or fiber by weight of dry materials before mixing.

(d) Materials other than gypsum concrete, used in combination with gypsum concrete to form a system of floor or roof construction, shall conform to the requirements of this code for such other materials, as regards strength, durability and fire-resistive quality.

SECTION 2704. *Strength of Gypsum Concrete.*—

(a) Gypsum concrete shall be classified according to mixture, and concrete of each class shall have minimum strength as follows:—

	Lbs. per sq. in.
Class 1: Neat (containing gypsum and water only) . . . . .	1,800
Class 2: Containing not more than three per cent of wood chips and fiber . . . . .	1,000
Class 3: Containing not more than twelve and one half per cent of wood chips and fiber . . . . .	500

(b) The strength of gypsum concrete shall be determined by compression tests of five cylinders six inches in diameter and twelve inches long, or upon five specimens, of which the length is twice the least transverse dimension, cut from precast gypsum units as the commissioner shall specify, dried to constant weight. The strength of the gypsum concrete for the purposes of this chapter shall be taken as the average

compressive strength of the five specimens, but not more than one third above the strength of the weakest specimen.

(c) Gypsum concrete which lacks the strength required for its classification may be used structurally, with the approval of the commissioner, provided the unit stresses are proportionately reduced, but gypsum concrete which has less compressive strength than five hundred pounds per square inch shall not be used structurally in a floor or roof.

**SECTION 2705. *Modulus of Elasticity of Gypsum Concrete.*** — (a) In the design of structural members of reinforced gypsum concrete the following values shall be used for the modulus of elasticity:—

	Lbs. per sq. in.
Class 1: Neat . . . . .	1,000,000
Class 2: Containing not more than three per cent of wood chips and fiber . . . . .	600,000
Class 3: Containing not more than twelve and one half per cent of wood chips and fiber . . . . .	200,000

**SECTION 2706. *Allowable Stresses in Gypsum Concrete.*** — (a) In the design of structural members of reinforced gypsum concrete the unit stress in the concrete shall not exceed the following allowable values:—

Maximum unit compression in bending . . . . .	0.25 $f_g$
Axial compression or bearing . . . . .	0.20 $f_g$
Bond on plain bars or wires . . . . .	0.02 $f_g$
Bond on deformed bars or wire mesh . . . . .	0.04 $f_g$
Shear (straight rods or wires) . . . . .	0.02 $f_g$
Shear (reinforcement anchored) . . . . .	0.03 $f_g$

In this table ( $f_g$ ) indicates the compressive strength of the gypsum concrete as specified in section twenty-seven hundred and four.

(b) Unit stress in steel reinforcement shall not exceed the values allowed in Part 26.

**SECTION 2707. *Poured-in-Place Gypsum Concrete.***

— (a) Floor and roof slabs of poured-in-place gypsum concrete shall be solid and of uniform thickness not less than two and one half inches.

(b) In the design of such slabs the gypsum concrete shall be assumed to act structurally in a manner similar to Portland cement concrete and the principles of design specified in Part 26 shall be applied.

(c) The span of poured-in-place gypsum concrete slabs shall not exceed six feet center to center of beams, except in so-called suspension construction in which the span shall not exceed eight feet.

(d) In suspension construction the reinforcing shall consist of wires continuous through multiple spans and anchored at the ends. The wires shall be supported in the top of the slab by the roof or floor beams and shall be pre-stressed by being drawn down as nearly to the bottom of the slab at mid-span as fire protection requirements will allow. In suspension construction the gypsum concrete may be so designed that a part or the whole of the total floor or roof load is supported by the slab in bending without exceeding the stresses allowed in this chapter. If the gypsum concrete is unable to support the entire load in bending, the remainder of the load shall be assumed supported by the wires in suspension, and provision shall be made in the framing of the floor

system for resisting the compressive forces due to end anchorage of the wires. The wires shall be designed for a tension per inch width of slab equal to —

$$\frac{w L^2}{8 d} \text{ pounds per inch}$$

in which  $w$  is the total load per square foot.

$L$  is the span in feet.

$d$  is the sag of the wire in inches.

**SECTION 2708. *Precast Gypsum Concrete.*** — (a) Precast gypsum concrete units for floor construction shall be of uniform thickness except for rabbets at supports, and shall be solid; such units for roof construction may be of uniform thickness, whether solid or hollow, or recessed on the under side. The span of precast gypsum concrete shall not exceed four feet in floors and six feet in roofs except in so-called suspension construction in which the span shall not exceed eight feet. For the purpose of this section any span over three feet shall be called long span.

(b) Except as otherwise provided in paragraph (c) of this section, precast gypsum concrete units shall have not less than the following thicknesses: —

(1) Solid units in roofs shall not be less than two inches thick, nor if long span, less than three inches thick.

(2) Solid units in floors shall not be less than two and one half inches thick, nor, if long span, less than four inches thick.

(3) Hollow units in roofs shall not be less than three inches, nor the shell in compression less than three fourths inch thick; if long span, the units shall be not less than five inches thick nor the shell in

compression less than one and three eighths inches thick.

(4) Recessed units in roofs shall be not less than five inches thick nor the panel less than one and three eighths inches thick.

(c) Precast solid reinforced gypsum concrete units not more than fifteen inches wide and bound on the long edges with structural or pressed sheet steel of approved design anchored to the units shall be not less than two inches thick. If the length of units is not less than one and one half times the span and the steel binding on the edges is designed to interlock with adjoining units in the manner of tongued and grooved wooden plank, and is of sufficient strength to transmit the load on one unit to adjoining units, the end joints may be staggered at random not less than two feet and the construction may be designed as continuous.

(d) Precast gypsum concrete units for floor and roof construction shall be reinforced and unless the shape or marking of the unit is such as to ensure its being placed right side up, the reinforcing shall be symmetrical so that the unit can support its load either side up.

(e) Precast gypsum concrete units of so-called suspension type shall be designed as provided in section twenty-seven hundred and seven for poured-in-place construction. The reinforcing wires of successive units in adjoining spans shall be connected by a method that will pre-stress them in tension, and the connection shall develop the full tensile strength of the wire or the allowed unit stress shall be proportionately reduced.

## PART 28.

## STEEL AND IRON.

## SECTION

- 2801 — Design of Steel and Iron.
- 2802 — Quality of Steel and Iron.
- 2803 — Allowable Stresses in Structural Steel.
- 2804 — Allowable Stresses in Cast Steel.
- 2805 — Allowable Stresses in Cast Iron.
- 2806 — Steel Tension Members.
- 2807 — Steel Columns.
- 2808 — Steel Beams and Girders.
- 2809 — Steel Connections and Details.
- 2810 — Cast Iron Columns.
- 2811 — Filled Pipe Columns.
- 2812 — Stresses in Steel due to Wind.
- 2813 — Thickness of Structural Steel.
- 2814 — Expansion and Contraction in Steel Frames.
- 2815 — Workmanship in Steel Construction.
- 2816 — Painting Steel and Iron.
- 2817 — Erection of Steel.
- 2818 — Steel Joists.
- 2819 — Column Bases of Steel and Iron.

SECTION 2801. *Design of Steel and Iron.* — Structures of steel and iron shall be designed by methods admitting of rational analysis according to established principles of mechanics, supplemented by the assumptions herein specified, to support the loads and withstand the forces to which they are subject without exceeding the stresses allowed in this part for the various members and the materials thereof.

SECTION 2802. *Quality of Steel and Iron.* — (a) The materials of steel and iron construction shall conform to the specifications of the American Society for Testing Materials as follows: —

- (1) Structural steel to Specifications for Steel for Bridges.
- (2) Rivet steel to Specifications for Structural Rivet Steel.
- (3) Cast steel to Specifications for Carbon Steel Castings.
- (4) Cast Iron to Specifications for Gray Iron Castings.

(b) Special steels, alloys, high carbon steel and other metals may be used in connection with steel and iron construction with the approval of the commissioner and subject to such conditions as he shall specify.

(c) Structural steel rolled prior to the year nineteen hundred and twenty-four shall not be stressed in excess of eight ninths the allowable stresses specified in this part.

(d) Structural steel which has previously been used in a building or other structure or which has been fabricated for such use, shall not be used in another building or structure except with the approval of the commissioner and under such conditions as he may in each case specify. Holes in second-hand material shall not be filled in such manner as will tend to hide their existence, and such filling, if discovered, shall justify the commissioner in refusing to allow the use of the material.

(e) The commissioner may require reasonable tests from time to time of steel and iron to determine its quality and whether it conforms to the requirements of this chapter.

SECTION 2803. *Allowable Stresses in Structural Steel.* — (a) The unit stress in members of rolled

structural steel, except the stress due to wind, shall not exceed the following allowable stresses, in pounds per square inch:—

(1) Tension, on net section . . . . . 18,000  
 (2) Compression in short members and where lateral

deflection is prevented . . . . . 18,000

(3) Compression in columns and compressive mem-  
 bers of trusses, axially loaded, on the gross  
 section:

where  $(\frac{L}{r})$  is not more than 60 . . . . . 15,000

and where  $(\frac{L}{r})$  is greater than 60 . . . . . 18,000

$$\frac{L^2}{1 + \frac{18,000}{r^2}}$$

in which (L) is the unbraced length and

(r) is the corresponding least radius  
 of gyration of the column section.

(4) Bending, maximum stress on the net section:

where lateral deflection is prevented or where

$(\frac{L}{b})$  is not more than 15 . . . . . 18,000

and where  $(\frac{L}{b})$  is greater than 15 . . . . . 20,000

$$\frac{L^2}{1 + \frac{2,000}{b^2}}$$

in which (L) is the unbraced length of the com-  
 pression flange, and

(b) is the width of the compression  
 flange.

(5) Shear, on the gross area of the webs of beams and  
 girders:

where  $(\frac{h}{t})$  is not more than 60 . . . . . 12,000

and where  $(\frac{h}{t})$  is greater than 60 . . . . . 18,000

$$\frac{h^2}{1 + \frac{7,200}{t^2}}$$

in which (h) is the height of the web in the clear between flanges or length in the clear between stiffeners, whichever is the lesser dimension, and

(t) is the thickness of the web.

(b) The bearing stress in members of rolled structural steel on pins, rivets and bolts with which they are connected, except the stress due to wind, shall not exceed the following allowable values in pounds per square inch:—

BEARING ON ITEMS —	Double Shear.	Single Shear.
Pins . . . . .	30,000	24,000
Rivets, power-driven . . . . .	30,000	24,000
Turned bolts in reamed holes . . . . .	30,000	24,000
Rivets, hand-driven . . . . .	20,000	16,000
Unfinished bolts . . . . .	20,000	16,000

(c) The unit stress in pins, rivets and bolts with which rolled structural steel members are connected, except the stress due to wind, shall not exceed the following allowable stresses in pounds per square inch:—

(1) Shear:

Pins . . . . .	13,500
Rivets, power-driven . . . . .	13,500
Turned bolts in reamed holes . . . . .	13,500
Rivets, hand-driven . . . . .	10,000
Unfinished bolts . . . . .	10,000

(2) Tension:

Rivets . . . . .	13,500
Bolts, on area at root of thread . . . . .	16,000

(3) Bending in pins . . . . . 27,000

(d) The bearing on expansion rollers in pounds per linear inch shall not exceed six hundred times the diameter in inches of the roller.

**SECTION 2804. *Allowable Stresses in Cast Steel.***  
— The unit tension, compression and shear in cast steel, except the stress due to wind, shall not exceed sixteen thousand pounds per square inch.

**SECTION 2805. *Allowable Stresses in Cast Iron.***  
— The unit stress in cast iron, except that due to wind, shall not exceed the following allowable stresses in pounds per square inch:—

(1) Tension	3,000
(2) Compression	10,000
(3) Compression in columns axially loaded	$9,000 - 40 \frac{L}{r}$

in which (L) is the unbraced length

(r) is the corresponding least radius of gyration of the column section.

(4) Bending:

In tension flange	3,000
In compression flange	10,000

**SECTION 2806. *Steel Tension Members.*** — (a) Structural steel members and their connections, subject to reversal of tension and compression due to the action of live loads, shall be designed to sustain either stress with half the other stress added, whichever requires the larger section. If the reversal of stress is due to the action of wind, the member shall be designed for the stress requiring the larger section

and the connections shall be designed for the larger stress.

(b) In calculating the net section of tension members, the area of rivet holes shall be deducted assuming the diameter of the hole to be at least one eighth inch larger than the nominal size of the rivet.

(c) Pin-connected tension members shall have an area of cross-section through the pin hole at least twenty-five per cent in excess of the net area required in the member, and a net area of cross-section back of the pin hole at least equal to the net area required on one side of the pin hole.

SECTION 2807. *Steel Columns.* — (a) The ratio  $(\frac{L}{r})$  shall not exceed one hundred and sixty for columns in buildings and main compression members in trusses and frames; nor two hundred for bracing and other secondary members.

(b) In structural steel columns and compression members of trusses, subject to eccentric loads or to bending other than that incidental to axial loading, the maximum unit compression shall not exceed eighteen thousand pounds per square inch —

(1) When calculated by a method which takes full account of deflection and buckling in any direction; or, —

(2) When the applied bending is in the plane of a principal axis and the stress is calculated by the following formula: —

$$\frac{P}{A} \left(1 + \frac{L^2}{18,000 r^2}\right) + \frac{Mc}{I - \frac{Ps^2}{10E}}$$

in which (M) is the applied bending.

(S) is the length of column unbraced in the plane of the bending.

(I) is the moment of inertia about a center of gravity axis perpendicular to the plane of the bending.

(c) is the distance from that axis to the remote fiber in compression.

$(\frac{L}{r})$  is the slenderness ratio at right angles to the plane of the applied bending.

(E) is the modulus of elasticity of steel.

SECTION 2808. *Steel Beams and Girders.* — (a) In rolled steel beams and girders, whether of solid section or built up, the ratio  $(\frac{L}{b})$  shall not exceed forty.

(b) The compression flanges of beams, girders, lintels and similar members in bending shall in general be braced laterally, by the floor or roof construction or framing, or by struts or tie rods. Steel joists, floor slabs or other construction, to be considered effective bracing shall have positive connection to the beam or girder and friction shall not be relied upon. Standard diaphragm separators, joining two members in bending, or steel pipe separators with concrete filling, shall be considered effective lateral support to each of the members.

(c) The span of beams and girders shall be taken as the distance from center to center of bearings. If a beam or girder is connected to the face of a flange or web of a column, the span shall be taken to such face.

(d) In calculations for stress due to bending in

built up beams and girders, and in rolled sections with punched flanges, the moment of inertia and section modulus of net sections shall be used.

(e) Where beams or girders are composed of two or more I-beams or channels, they shall be so connected as properly to distribute the load to each member.

(f) Beams, girders, and trusses of steel shall be so designed that the deflection under load shall not exceed one three hundred and sixtieth of the span. The modulus of elasticity of rolled steel shall be taken as twenty-nine million pounds per square inch.

(g) Beams and girders subject to the thrust of floor arches, purlins or inclined roofs, crane runway girders and other members subject to bending in more than one plane shall be so designed that the maximum unit stress due to combined loading shall not exceed the stress allowed in this chapter, except as provided in section twenty-eight hundred and twelve. Eccentric loads shall be provided for.

(h) Beams which are wholly encased, as required for fireproofing, in the concrete of a reinforced concrete floor or roof may be designed for bending as composite beams, as provided in Part 26.

(i) Plate girder webs shall have a thickness not less than one one hundred and sixtieth of the clear distance between flanges, nor less than one fourth inch.

(j) Web splices shall have at least one plate on each side of the web riveted thereto in such manner that the shear is transmitted; and bending, if the web is designed to resist bending.

(k) Stiffeners shall be provided on both sides of the webs of plate girders over end bearings and where

necessary at points of concentrated loads, designed to transmit the reactions and loads to the web. Bearing stiffeners shall not be crimped over flange angles, and shall be fitted to the flange angles where they bear. Where the ends of stiffener angles are chamfered to clear the fillets of flange angles, the outstanding legs only shall be computed in bearing and the average unit stress in bearing shall not exceed twenty-four thousand pounds per square inch. Where stiffener angles are raised from the web on fillers to clear the fillets of flange angles and the whole of the stiffener angle is fitted in bearing, the average unit stress shall not exceed eighteen thousand pounds per square inch.

(l) Fitted stiffeners shall also be provided on the webs of rolled I-beams and channels where necessary to transmit to the web the end reactions or concentrated loads.

(m) Intermediate stiffeners shall be provided on both sides of the webs of plate girders where the thickness of the web is less than one sixtieth of the clear distance between flanges. The clear spacing of such stiffeners shall not exceed six feet, nor be more than, —

$$85 t \frac{\sqrt{18,000 A}}{V} - 1$$

in which (A) is the gross area of the web.

(V) is the shear.

(t) is the thickness of the web.

But such stiffeners need not be provided where other adequate provision is made against buckling and torsion. Intermediate stiffeners shall overlap but need not bear on the flange angles.

SECTION 2809. *Steel Connections and Details.* —

(a) Rivets driven in the field or shop by approved pneumatic hammers shall be considered power-driven rivets. Turned bolts shall have a clearance in reamed holes not more than one fiftieth inch; holes shall be reamed after assembly of the members connected. The finished shank of turned bolts shall be long enough to provide full bearing, with washers under the nuts to permit tight gripping of members when turned up, and nuts shall be locked.

(b) Riveted joints shall be designed to transmit the entire stress through the rivets, except as otherwise provided in paragraph (c).

(c) Joints in compression members shall be fully spliced, except that where reversal of stress is not possible and the joint is supported laterally, the ends of the members may be milled to plane, parallel surfaces and abutted, with sufficient splicing to hold the connected members accurately and firmly in place and in bearing.

(d) Riveted connections transmitting calculated stress, except in lacing and sag bars, shall have not less than two rivets.

(e) Members in tension or compression meeting at a joint shall have their lines of center of gravity pass through a point, if practicable; and if not, provision shall be made for the eccentricity.

(f) A group of rivets transmitting stress to a member shall have its center of gravity in the line of stress if practicable; and if not, the group shall be designed for the resulting eccentricity.

(g) When a beam or girder is connected by a connection more rigid than a standard web connection, to a supporting member in such a way that it acts

as continuous or fixed at the end, proper provision shall be made for the bending at the connection.

(h) When stress is transmitted from one member to another by rivets through a filler, the number of rivets shall be increased thirty per cent over the number required for connecting members in contact. The additional rivets so provided may be used to produce a tight filler.

(i) In designing riveted or bolted connections, the nominal diameter of the rivet or bolt shall be used.

(j) Rivets transmitting calculated stress, when the grip exceeds five diameters, shall be increased in number one per cent for each additional one tenth inch in grip.

(k) The required strength of riveted connections shall be developed by the shearing and bearing values of the rivets, but rivets in shelf angles or bracket supports, and in connections in so far as they also afford rigidity to the structure, may transmit stress by tension.

(l) The rivet pitch in the line of stress in compression members shall not exceed sixteen times the thickness of the thinnest outside plate or shape nor twenty times the thickness of the thinnest inclosed plate or shape, nor in any case more than twelve inches. At right angles to the direction of stress the distance between lines of rivets shall not exceed thirty times the thinnest plate or shape.

(m) In built up sections with angles having two gage lines with rivets staggered, the rivet pitch in the line of stress in each gage line shall not exceed twenty-four times the thickness of the thinnest plate or shape, nor eighteen inches.

(n) The distance from the center of rivet holes to

an edge shall not exceed twelve times the thickness of the thinnest plate or shape nor six inches.

(o) The provisions of this section for riveted connections shall also apply, where pertinent, to bolted connections.

(p) Rivets or turned bolts shall be used for either shop or field work in the fabrication and erection of primary members, members carrying loads which produce impact or vibration and in connections subject to reversal of stress, except as otherwise provided in paragraphs (q) and (r).

(q) Unfinished bolts may be used for primary and secondary field connections in buildings other than Type I and Type II, in buildings of Type I and Type II less than ten thousand square feet in total floor area, and in the connections to cast iron or filled pipe columns, connections of secondary members in all structures, such as purlins, girts, door and window framing, alignment bracing, and secondary beams in floors and roofs.

(r) Fusion welding may be substituted for, or used in combination with riveting or bolting to connect or assemble component parts of steel beams, girders, lintels, trusses, columns and other structural steel used in building construction if done under rigid inspection in accordance with approved specifications.

SECTION 2810. *Cast Iron Columns.*—(a) Cast iron columns shall not be used in the primary structural frames of buildings whose height exceeds one hundred feet or twice the width at the ground level. Cast iron shall not be used for columns required to have four-hour fire-resistive protection.

(b) The ends of cast iron columns shall be machined to a smooth plane surface perpendicular to the axis to provide full bearing for the entire cross-section of the column.

(c) Hollow cast iron columns, except when open at both ends and without flanges, shall have two three eighths inch holes drilled in the shell to exhibit the thickness thereof. If the columns are cast on the side, both holes shall be in the top side as cast, one hole about twelve inches toward each end from mid-length of the column. If the columns are cast on end, both holes shall be at mid-height at ninety degrees from one another about the axis of the column. Additional holes shall be drilled when required by the commissioner. If the core of a cast iron column is found to have shifted more than one quarter the thickness of the shell, the strength shall be computed assuming the thickness all around to be that of the thinnest part.

(d) Cast iron columns shall not be smaller than six inches in outside diameter or side, and the thickness of metal shall not be less than three fourths inch nor less than one twelfth the outside diameter or widest side.

(e) Cast iron columns supporting a floor shall not be longer than seventy times the least radius of gyration or twenty-four times the outside diameter or least side. Cast iron columns supporting roof loads only shall not be longer than ninety-six times the least radius of gyration or thirty times the outside diameter or least side.

(f) Cast iron columns shall not be used where the loading is so eccentric as to cause tension, nor shall

they be used in garages or other structures where they may be subject to impact from vehicles.

**SECTION 2811. *Filled Pipe Columns.*** — (a) Steel or wrought iron pipes or tubing filled with concrete may be used as columns. Their capacity under axial load shall be assumed as not more than that of the pipe or tube computed as provided in this chapter plus the capacity of the concrete. The average stress on the concrete shall not exceed one fourth the twenty-eight day strength of the concrete according to its proportions determined as specified in Part 26.

(b) The pipe or tubing shall be new material of steel or wrought iron. If the material of the shell has a lower yield point in tension or compression than structural steel the allowable stress shall be reduced proportionally. Shells shall be cut square to length and shall be straight before filling. Shells larger than four inches in outside diameter shall not be thinner than standard steel pipe.

(c) Concrete filling for pipe columns shall be proportioned for a strength of not less than three thousand pounds per square inch as specified in Part 26.

(d) Longitudinal steel reinforcement in filled pipe columns, when straight, symmetrically placed and faced for bearing at the ends shall be assumed to be integral with the shell, and the radius of gyration of the combined metal cross-section shall be used with the allowable unit stress of the weaker metal in computing the capacity of the columns. Suitable arrangement shall be made for bearing on the ends of reinforcement.

(e) Cap plates of filled pipe columns shall be of steel and shall be firmly attached to the tops of the columns by an approved method. Brackets may be used under cap plates where desired to avoid excess of local stress.

(f) Material surrounding a filled pipe column for fire protection shall not be considered either load-bearing or as increasing the radius of gyration.

(g) When required by the commissioner, an applicant for permit for construction with concrete filled pipe columns shall employ an inspector satisfactory to the commissioner who shall inspect the filling of the column and attach a permanent label to columns inspected and approved.

**SECTION 2812. *Stresses in Steel due to Wind.*** — Structural steel members subject to stress due to wind shall be so designed that the maximum unit stress from all loads and forces combined shall not exceed by more than one third the allowable stresses specified in this chapter and the unit stress due to loads and forces other than wind shall not exceed the specified allowable stresses.

**SECTION 2813. *Thickness of Structural Steel.*** — The thickness of metal in structural members of steel shall be not less than one quarter inch where protected from moisture and from the weather, and five sixteenths inch where exposed to moisture or the weather, except the edges of flanges and the webs of rolled beams and channels, steel joists as defined in section twenty-eight hundred and eighteen, stairs, fire escapes, signs, skylights, windows, non-bearing walls and partitions, suspended ceilings, cornice

brackets, ventilator hoods and other light iron work, and structural steel for buildings of Type V one story high.

**SECTION 2814. *Expansion and Contraction in Steel Frames.***—Proper provision shall be made for expansion and contraction.

**SECTION 2815. *Workmanship in Steel Construction.***—(a) Structural steel members shall be straight and true and any piece damaged to such an extent as to impair its strength shall not be used in the construction of a building.

(b) Structural steel members shall not be cut, notched, or pierced for clearance of pipes, conduits, wires, ducts, or for other reasons, in such a way as to impair their strength unless provision therefor has been made in the design.

(c) Drifting to enlarge unfair holes shall not be permitted. Rivet holes shall not be burned.

(d) The several pieces forming built-up sections shall be straight and shall fit closely together; and finished members shall be free from twists, bends or open joints.

(e) Rolled sections shall not be heated in any manner which will impair their strength or quality, nor cut with the torch while under stress. A torch shall not be used in the field to cut structural steel except with the approval of the commissioner and in the presence of an inspector appointed by him.

(f) Steel castings shall be properly annealed.

(g) Except under such conditions as the commissioner may specify, rivets shall be driven at bright

red heat, and wherever practicable, by power riveters. Rivet heads shall be of hemispherical shape, uniform in size throughout the work for the same size rivet, full, neatly finished and concentric with the holes. Rivets after driving, shall be tight, completely filling the holes, and with heads in full contact with the gripped surfaces.

SECTION 2816. *Painting Steel and Iron.*—(a) Structural steel (except the parts which are to be welded, surfaces in contact, or entirely encased in concrete) shall be thoroughly cleaned before erection and painted one coat of approved paint well worked into joints and open spaces including surfaces which have been welded.

(b) After erection, steel work (except that which is to be encased in concrete) shall be painted an additional approved coat of another color.

(c) Required shop painting of shop-welded work shall be applied after the welding is completed. Required shop painting of work to be field welded shall consist of a coat of linseed oil. Required field painting of field-welded work shall be applied after welding is finished and shall consist of two coats of approved paint.

(d) Steel which is part of the primary frame of a building, embedded in exterior masonry walls, shall be protected from corrosion by a trowel coating of mastic asphalt or pitch not less than one eighth inch thick, or its approved equivalent, in lieu of the painting specified in this section.

(e) Welded connections and cast iron columns shall not be painted until after inspection and approval by the commissioner.

**SECTION 2817. *Erection of Steel.*** — (a) The steel frames of buildings or other structures shall be erected true and plumb, and temporary bracing shall be provided wherever necessary to support the loads to which the structure may be subjected, including erection equipment and its operation. Such bracing shall be left in place as long as required for safety.

(b) As erection progresses, the work shall be securely bolted up to resist all stresses to which it may be subjected.

(c) No field riveting or welding shall be done in any portion of a structure until that portion has been properly plumbed and aligned.

(d) In the setting or erecting of steel work the individual pieces shall be considered plumb or level when the error does not exceed one in five hundred. Exterior columns and columns adjacent to elevator shafts shall not be out of plumb in excess of one in one thousand, in the total height of the columns.

**SECTION 2818. *Steel Joists.*** — (a) Steel joists, for the purposes of this chapter, shall mean light weight rolled steel sections, welded truss assemblies or expanded rolled sections. They shall include —

(1) Junior Beams, so-called.

(2) Other rolled steel beams of (I) or channel section the flanges of which are narrower than two inches plus one sixth the depth (except American standard channels) or the webs of which are thinner than seventeen hundredths inch plus five thousandths of the depth.

(3) Beams of I-section or channels, fabricated by bending, pressing or expanding sheet steel.

(4) Steel joists, so-called, consisting of trussed members of which the chords are made of bars or of structural shapes thinner than one quarter inch, or the webs are made of bars; assembled by welding or otherwise; or fabricated by shearing and expanding the web of rolled I-beam; or any similar trussed steel beam.

(b) Steel joists shall not be more than twenty inches deep.

(c) Steel joists shall not be used in floors of Group E, or of Divisions 2, 3, and 4 of Group F, or of Group G occupancy, nor in floors supporting live load in excess of seventy-five pounds per square foot.

(d) The provisions of this chapter for design and materials of structural steel shall apply to steel joists.

(e) Every steel joist, when erected and bridged, shall be capable of supporting safely a concentrated load of at least eight hundred pounds at any panel point. Welded joints of trussed joists, when tested shall be capable of resisting at least three times the maximum design stress.

(f) The span of steel joists shall not exceed one hundred and sixty times the width of the top chord or top flange nor twenty-four times the depth of the joist, except that the span of joists with solid webs may be longer if the deflection under live load will not exceed one three hundred sixtieth of the span.

(g) Bridging shall be provided for steel joists to afford lateral support during erection and to distribute concentrations of live load among adjacent joists. Bridging shall be of approved rigid type capable of transmitting at least five hundred pounds to each

adjacent joist and shall securely support the top chord or flange against lateral displacement. Such bridging shall be provided at intervals not more than eight feet nor more than forty times the width of the top flange or chord. Unless steel joists are supported at the ends by web connections, built into masonry walls or otherwise supported laterally, they shall have bridging at the ends.

(h) Steel joists parallel to masonry walls or to steel or concrete beams shall have both top and bottom chords or flanges anchored thereto in the line of bridging. Such anchors shall consist of flat steel not less than one inch by one eighth inch effectively arranged, or other equivalent approved anchorage.

(i) Steel joists shall have at least four inches bearing on masonry walls and shall be anchored thereto by approved anchor. Steel joists supported on the top of steel beams shall have at least three inches bearing and shall extend at least one inch beyond the center line of the web. Steel joists depended upon for lateral support to a beam shall have positive connection thereto other than by friction. Steel joists shall be secured against lateral displacement at the ends.

(j) Steel joists shall not be used in the first floor of a building where there is not a basement or cellar below, unless it has clearance above the ground of at least twenty-four inches, and the space below is ventilated either to a heated basement or to the outside air. Ventilation of such space to a heated basement shall consist of at least two remote openings in the basement wall having a total area of at least two square feet for each twenty-five linear feet

of wall. Ventilation of such space to outside air shall consist of one or more openings in each exterior wall thereof, well distributed, except that openings need not be provided in the front wall when the space is ventilated in the rear and both side walls. The aggregate area of openings shall be not less than two square feet for each twenty-five linear feet of wall. Openings in exterior walls shall be protected by non-corrodible wire mesh with openings not greater than one half inch.

SECTION 2819. *Column Bases of Steel and Iron.*

— (a) Steel or cast iron bases under steel, cast iron or filled pipe columns shall be plane and smooth. They shall be designed on the assumption that the column bears uniformly upon the base, and that the base bears uniformly upon the supporting foundation, except when the column is anchored to the foundation to resist calculated bending.

(b) Cast iron bases shall be planed on top and bases which rest on structural steel members shall be planed on the bottom. The thickness of cast iron shall be not less than one inch. The outer edge of the ribs of ribbed bases shall be inclined not less steeply than forty-five degrees. A side of the bed plate of ribbed bases exceeding three feet in length shall have a reinforcing flange at least three inches high.

## PART 29.

## EXCAVATIONS AND FOUNDATIONS.

## SECTION

- 2901 — Excavations.
- 2902 — Depth of Foundations.
- 2903 — Borings and Test Pits.
- 2904 — Classification and Allowable Loads of Foundation Bearing Materials.
- 2905 — Foundation Loads.
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- 2914 — Composite Piles.
- 2915 — Foundation Load Tests.
- 2916 — Load Tests of Bearing Materials.
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SECTION 2901. *Excavations.* — (a) Until provision for permanent support has been made, excavations shall be properly guarded and protected by the persons causing them to be made so as to prevent such excavation from becoming dangerous to life or limb. Excavations shall be sheet-piled, braced or shored, and permanent excavations shall be protected by retaining walls or other permanent structures, where necessary, to prevent movement or caving of the adjoining soil.

(b) Structures near an excavation and owned by another than the person causing the excavation to be made shall be supported as follows: —

(1) Where an excavation is carried to a depth of more than ten feet below the curb grade at the common property line, or below the surface of the ground where there is no such curb grade, the person causing

such excavation to be made shall, at all times, if accorded the necessary license to enter upon the adjoining land, and not otherwise, at his own expense, preserve and protect from injury any wall, building, or structure, the safety of which may be affected by said excavation, and shall support it by proper foundations. If the necessary license is not accorded to the person making such excavation, then it shall be the duty of the owner refusing to grant such license to make such wall, building or structure safe and to support it by proper foundations; and, when necessary for that purpose, such owner shall be permitted to enter upon the premises where such excavation is being made.

(2) Where an excavation is carried to a depth of ten feet or less below the curb grade at the common property line, or below the surface of the ground where there is no such curb grade, except as provided in paragraph (3) of this section, the owner of any wall, building, or structure, the safety of which may be affected by said excavation, shall preserve and protect it from injury, and shall support it by proper foundations; and, when necessary for that purpose, shall be permitted to enter upon the premises where such excavation is being made.

(3) Where a party wall is intended to be used by the person causing the excavation to be made, he shall, at his own expense, preserve such party wall from injury and shall support it so that the said party wall shall be safe for the purposes intended.

(c) If the person whose duty it shall be under the provisions of this section to guard and protect an excavation, or to prevent adjoining soil from moving or caving, or to preserve or protect any wall, build-

ing, or structure from injury, shall neglect or fail so to do, the commissioner may enter upon the premises, and make safe such excavation, wall, building or other structure as provided in section sixteen of Part 1.

SECTION 2902. *Depth of Foundations.* — (a) The foundations of every permanent structure shall be supported by satisfactory bearing material, which shall mean natural deposits of rock, gravel, sand, rock flour (inorganic silt), clay, or any combination of these which does not contain and does not overlie an appreciable amount of organic matter.

(b) Where footings are supported at different levels, or at different levels from footings of adjacent structures, foundation plans shall include vertical sections showing to true scale all such variations in grade. The effect of such differences in footing levels on the bearing materials shall be considered in the design.

(c) The foundations and grade beams of permanent structures, except when founded on rock, and except as otherwise provided in paragraph (d) of this section, shall be carried down at least four feet below an adjoining surface exposed to natural or artificial freezing.

(d) Foundations of detached garages or similar accessory structures of six hundred fifty square feet or less in area and not over one story high, and grade beams of all structures need not be carried more than one foot below an adjoining surface exposed to freezing if the underlying soil to a depth of at least four feet beneath the surface is clean sand and gravel. No foundation shall be placed on frozen

soil. Foundations shall not be laid in freezing weather unless adequately protected.

(e) Basements or cellars which are surrounded by water-bearing soil shall be waterproofed up to a grade at least two feet above the maximum probable ground water level. Walls and floors to be so waterproofed shall be designed to resist full hydrostatic pressure. Under boilers, furnaces and other heat producing apparatus, suitable insulation shall be installed to protect the waterproofing against damage from heat as specified in Part 21.

**SECTION 2903. *Borings and Test Pits.*** — (a) Before issuing a permit for erection or alteration of a permanent structure, the commissioner, in the absence of satisfactory data, shall require the owner to dig pits or make borings at such locations and carried to such depths as will disclose the character of the materials underlying the site of the proposed structure. When it is proposed to support a structure directly on bedrock, loading the rock to more than ten tons per square foot, the commissioner may require a drill hole or a core boring to be made at each pier location, carried into the rock a sufficient depth to prove that sound bedrock has actually been reached.

(b) Copies, in duplicate, of the results of all borings and pits made or started, together with samples properly protected from evaporation representing the various classes of soil as nearly as possible in their natural state in the ground, including samples of the materials selected for the support of the foundation, shall be filed with the commissioner for his informa-

tion and classification. Washed or bucket samples will not be accepted.

**SECTION 2904. *Classification and Allowable Loads of Foundation Bearing Materials.*** — (a) The terms used in the following classification shall be interpreted in accordance with generally accepted geological and engineering nomenclature. Certain terms shall, for the purposes of this chapter, have more specific interpretations, as follows:

(1) **Rocks.**

**Shale;** — A laminated, fine-textured, soft rock composed of consolidated clay or silt, which cannot be molded without the addition of water, but which can be reduced to a plastic condition by moderate grinding and mixing with water.

**Slate;** — A dense, very fine-textured, soft rock which is readily split along cleavage planes into thin sheets and which cannot be reduced to a plastic condition by moderate grinding and mixing with water.

**Schist;** — A fine-textured, laminated rock with a more or less wavy cleavage, containing mica or other flaky minerals.

(2) **Granular soil.**

**Gravel;** — An uncemented mixture of mineral grains one quarter inch or more in diameter.

**Sand;** — A type of soil possessing practically no cohesion when dry, and consisting of mineral grains smaller than one quarter inch in diameter.

**Coarse Sand;** — A sand consisting chiefly of grains which will be retained on a sixty-five mesh sieve.

**Fine Sand;** — A sand consisting chiefly of grains which will pass a sixty-five mesh sieve.

Compact Gravel, Compact Sand; — Deposits requiring picking for removal and offering high resistance to penetration by excavating tools.

Loose Gravel, Loose Sand; — Deposits readily removable by shoveling only.

(3) Cohesive soil.

Hardpan; — A thoroughly compact mixture of clay, sand, gravel, and boulders, for example boulder clay; or a cemented mixture of sand or of sand and gravel, with or without boulders, and difficult to remove by picking.

Clay; — A fine-grained, inorganic soil possessing sufficient cohesion when dry to form hard lumps which cannot readily be pulverized by the fingers.

Hard Clay; — A clay requiring picking for removal, a fresh sample of which cannot be molded in the fingers, or can be molded only with the greatest difficulty.

Medium Clay; — A clay which can be removed by spading, a fresh sample of which can be molded by a substantial pressure of the fingers.

Soft Clay; — A clay which, when freshly sampled, can be molded under relatively slight pressure of the fingers.

Rock Flour (Inorganic Silt); — A fine-grained, inorganic soil consisting chiefly of grains which will pass a two hundred mesh sieve, and possessing sufficient cohesion when dry to form lumps which can readily be pulverized with the fingers.

(b) The maximum pressure on soils under foundations shall not exceed the allowable bearing values set forth in the following table except when determined in accordance with the provisions of sections twenty-nine hundred and fifteen and twenty-nine

hundred and sixteen, and in any case subject to the modifications of subsequent paragraphs of this section.

CLASS.	Material.	Allowable Bearing Value (Tons per Square Foot).
1	Massive bedrock without laminations, such as granite, diorite, and other granitic rocks; and also gneiss, trap rock, felsite and thoroughly cemented conglomerates, such as the Roxbury Puddingstone, all in sound condition (sound condition allows some cracks).	100
2	Laminated rocks such as slate and schist, in sound condition (some cracks allowed).	35
3	Shale in sound condition (some cracks allowed) . . . . .	10
4	Residual deposits of shattered or broken bedrock of any kind except shale.	10
5	Hardpan . . . . .	10
6	Gravel, sand-gravel mixtures, compact . . . . .	5
7	Gravel, sand-gravel mixtures, loose; sand, coarse, compact . . .	4
8	Sand, coarse, loose; sand, fine, compact . . . . .	3
9	Sand, fine, loose . . . . .	1
10	Hard clay . . . . .	6
11	Medium clay . . . . .	4
12	Soft clay . . . . .	1
13	Rock flour, shattered shale, or any deposit of unusual character not provided for herein.	-1

<sup>1</sup> Value to be fixed by the commissioner.

(c) The tabulated bearing values for rocks of Classes 1 to 3 inclusive shall apply where the loaded area is less than two feet below the lowest adjacent surface of sound rock. Where the loaded area is more than two feet below such surface these values may be increased twenty per cent for each foot of additional depth but shall not exceed twice the tabulated values.

(d) The allowable bearing values of materials of Classes 4 to 9 inclusive may exceed the tabulated values by two and one half per cent for each foot of depth

of the loaded area below the lowest ground surface immediately adjacent, but shall not exceed twice the tabulated values. For areas of foundations smaller than three feet in least lateral dimension, the allowable bearing values shall be one third of the allowable bearing values multiplied by the least lateral dimension in feet.

(e) The tabulated bearing values for Classes 10 to 12 inclusive apply only to pressures directly under individual footings, walls, and piers. When structures are founded on or are underlain by deposits of these classes, the total load over the area of any one bay or other major portion of the structure, minus the weight of excavated material, divided by the area, shall not exceed one half the tabulated bearing values.

(f) Where the bearing materials directly under a foundation overlie a stratum having smaller allowable bearing values, these smaller values shall not be exceeded at the level of such stratum. Computation of the vertical pressure in the bearing materials at any depth below a foundation shall be made on the assumption that the load is spread uniformly at an angle of sixty degrees with the horizontal; but the area considered as supporting the load shall not extend beyond the intersection of sixty degree planes of adjacent foundations.

(g) Where portions of the foundation of an entire structure rest directly upon or are underlain by medium or soft clay or rock flour, and other portions rest upon different materials, or where the layers of such softer materials vary greatly in thickness, the magnitude and distribution of the probable settlement shall be investigated as specified in section

twenty-nine hundred and sixteen, paragraph (f) and, if necessary, the allowable loads shall be reduced or special provisions be made in the design of the structure to prevent dangerous differential settlements.

(h) Whenever, in an excavation, an inward or upward flow of water develops in an otherwise satisfactory bearing material, special methods satisfactory to the commissioner shall be immediately adopted to stop or control the flow to prevent disturbance of the bearing material. If such flow of water seriously impairs the structure of the bearing material, the allowable bearing value shall be reduced to that of the material in loose condition.

SECTION 2905. *Foundation Loads.* — (a) The loads to be used in computing the maximum pressure upon bearing materials under foundations shall be the live and dead loads of the structure, as specified in Part 23, including the weight of the foundations, but excluding loads from overlying soil.

(b) Eccentricity of loading in foundations shall be fully investigated and the maximum pressure shall not exceed the allowable bearing values.

(c) Where the pressure on the bearing material due to wind is less than twenty-five per cent of that due to dead and live loads, it may be neglected in design. Where this ratio exceeds twenty-five per cent, foundations shall be so proportioned that the pressure due to combined dead, live and wind loads shall not exceed the allowable bearing values by more than twenty-five per cent.

SECTION 2906. *Foundation Design.* — Foundations shall be designed to distribute to the supporting

media all vertical, horizontal and inclined loads, as specified in section twenty-nine hundred and five, without exceeding the allowable stresses specified elsewhere in this code for the materials of which the foundations are to be constructed. Concrete in foundations shall have stone or gravel aggregate and shall be proportioned for an ultimate strength of at least fifteen hundred pounds per square inch.

*SECTION 2907. Footings, Caisson Piers and Pile Caps.* — (a) The footings of foundation walls or piers shall be of plain or reinforced concrete or other satisfactory masonry units, footing stones, or steel grillages. Footings of wood may be used under temporary structures and, where they are entirely below the permanent ground water level, as determined by the commissioner, under permanent structures of Type V or Type VI.

(1) Concrete footings and pile caps shall be designed in accordance with the provisions of Parts 24 and 26.

(2) Footing stones shall be at least ten inches in thickness and shall be fully bedded. They may be laid dry for buildings not exceeding four stories in height. For buildings higher than four stories, they shall be laid in cement mortar. Stresses in footing stones shall not exceed the maximum specified in Part 24.

(3) Structural steel grillage foundations shall be designed in accordance with the provisions of Part 28, shall have at least six inches of concrete below the steel and shall be entirely embedded in and surrounded by concrete at least four inches thick between steel and soil.

(4) Wooden footings shall be designed in accordance with the provisions of Part 25.

(b) Caisson piers may be constructed of either plain or reinforced concrete. The unit compressive stress in the concrete at the least cross-section shall not exceed  $0.225 f'_c$ . When the height of the shaft H exceeds 18 D such stress shall not exceed

$$0.225 f'_c (1.5 - \frac{H}{36D}) \text{ wherein:}$$

$f'_c$  = the ultimate compressive strength of the concrete as specified in Part 26.

H = length of shaft in feet measured from the top of the bell to cut-off.

D = shaft diameter — in feet when the shaft is of constant cross-section.

D =  $d + 0.014 H$  when the shaft increases two inches in diameter each six feet plus or minus in height.

d = shaft diameter in feet at top of bell.

The stress in the vertical steel shall not exceed ten thousand pounds per square inch.

(c) In reinforced concrete caisson piers the vertical steel shall have an area at least one half of one per cent of the minimum area of cross-section of the concrete. Such steel shall be stayed laterally by steel ties equivalent at least to one quarter inch round bars spaced twelve inches on center.

(d) The bell of a belled pier shall have at least four inches thickness at its edge and, unless designed as a spread footing, the sides shall slope at an angle of not less than sixty degrees with the horizontal.

(e) Whenever the center of cross-section of a caisson pier at any level deviates from the center of the

load more than one sixtieth of its height or more than one tenth its diameter it shall be reinforced according to paragraph (c) of this section.

(f) Piles under buildings of Types I to IV, inclusive, shall be capped with concrete proportioned for an ultimate strength of at least two thousand pounds per square inch, or with block granite. Concrete capping for piles shall extend not less than twelve inches above the pile heads and shall fill the space between and around the piles for a depth of at least three inches. The minimum horizontal distance from the edge of the cap to the nearest pile surface shall be three inches and there shall be at least two inches of concrete between the top of a pile and steel reinforcement. Block granite capping shall be not less than twelve inches thick. Each block shall have a bearing on at least two piles and shall be bedded in cement mortar applied to the pile heads. The capping blocks shall be sufficiently large to cover all pile heads.

(g) Foundation walls shall conform to the requirements of Part 14.

**SECTION 2908. *Piles — General Requirements.*** —  
(a) A detached column or pier supported by piles shall rest upon not less than three piles, but a column or pier connected to permanent construction, which provides adequate lateral support to the top of the piles, may rest upon a single pile, or upon two piles.

(b) A foundation wall of a building not more than one story nor more than twenty feet high, if supported laterally by masonry, reinforced concrete or steel construction at intervals not exceeding twenty

feet, may be supported by a single row of piles. If the distance between such lateral supports exceeds ten feet, the capping shall be continuous and shall consist of a structural steel grillage or reinforced concrete at least two feet wide in which the number of square inches of longitudinal steel reinforcement near each vertical face is at least one eighth times the length in feet between lateral supports. Other foundation walls supported upon piles shall rest upon at least two rows of piles. The outer rows shall be at least two feet apart on centers under buildings up to thirty feet in height and at least three feet apart under buildings higher than thirty feet.

(c) The excavation for pile foundations, wherever practicable, shall be completed to pile cut-off grade, or lower, before piles are driven. In no case shall piles be driven through more than three feet of un-excavated material above pile cut-off grade.

(d) The method of driving shall be such as not to impair the strength of the pile and shall meet with the approval of the commissioner. A steel or iron follower may be used subject to his approval. It shall be equipped with a suitable socket encasing the pile head sufficiently to prevent damage while driving. Shattered, broomed or otherwise damaged pile heads shall be cut back to sound material before driving with the follower. If a wooden driving block is used, it shall, at the time it is used for measuring the penetration, be of sound hard wood equal to oak, not more than twelve inches in height, with the grain parallel to the axis of the pile, and shall be enclosed in a steel casing of adequate strength to resist lateral distension.

(e) Piles shall not be jetted except with specific approval of the commissioner. After jetting, piles shall be driven to the required resistance.

(f) Additional piles shall be driven to replace piles injured during driving, and to supplement piles having capacity less than required by the design.

(g) Types of pile construction not specifically provided for in this part shall meet such additional requirements as may be prescribed by the commissioner.

**SECTION 2909. *Allowable Load on Piles.*** — (a) The supporting capacity of the piles shall be obtained from bearing upon or embedment in satisfactory bearing materials as defined in section twenty-nine hundred and four.

(b) The allowable pile loading shall be limited by the provision that the vertical pressures in the bearing materials at or below the points of the piles produced by the loads on all piles in a foundation shall not exceed the allowable bearing values of such materials, as specified in sections twenty-nine hundred and four, twenty-nine hundred and fifteen, and twenty-nine hundred and sixteen. Piles or pile groups shall be assumed to transfer their loads to the bearing materials by spreading the load uniformly at an angle of sixty degrees with the horizontal, starting at a polygon circumscribing the piles at the top of the satisfactory bearing stratum in which they are embedded, but the area considered as supporting the load shall not extend beyond the intersection of the sixty degree planes of adjacent piles or pile groups.

(c) The allowable load on each pile shall be further limited by the requirement that such load shall not

cause excessive movement of the pile relative to the soil. Satisfactory proof of this load for all soil conditions and all types of piles can be obtained from load tests conducted in accordance with section twenty-nine hundred and seventeen. In the absence of such proof of the supporting capacity, the load on any pile shall not exceed the allowable value determined in accordance with paragraphs (d) to (k) inclusive of this section.

$$(d) (1) R = \frac{3 Wh}{s + k} \times \frac{W}{W+P} \text{ for drop hammers.}$$

$$(2) R = \frac{3.6 Wh}{s + k} \times \frac{W}{W+P} \text{ for single-acting steam hammers.}$$

$$(3) R = \frac{4 F}{s+k} \times \frac{W}{W+P} \text{ for double-acting steam hammers.}$$

in which  $W$  = Weight of striking part of hammer in pounds.

$h$  = Height of fall of hammer in feet.

$P$  = Weight of pile as driven, in pounds.

$s$  = Average penetration per blow, in inches, for the last five blows.

$R$  = Allowable pile load in pounds.

$F$  = Actual energy delivered per blow in foot pounds.

$$k = \frac{3 RL}{2 AE} + C \text{ in inches.}$$

$L$  = Length of pile or apparatus being driven, in inches.

A = Average sectional area of pile material,  
as driven, in square inches.

E = Modulus of elasticity of pile material,  
as driven, in pounds per square inch.

C = Constant = 0.05, for a wooden pile or  
driving cap.

(e) In computing the allowable load of a pile driven with a follower, the value of (k) computed for the follower itself shall be added to the value of (k) for the pile; the weight of the follower shall be added to the weight of the pile and included in (P).

(f) The value of (k) may be determined from the allowable pile load assumed in the design unless the allowable load computed from the penetration varies more than twenty per cent from such assumed load. Information necessary for the computation of (k) shall be furnished to the commissioner.

(g) Double-acting steam hammers shall be equipped with an approved device for determining the actual energy in foot pounds per blow delivered.

(h) The penetration (s) for an allowable pile load (R), must not exceed the following:

$$(1) \quad s = \frac{3 Wh}{R} \times \frac{W}{W+P} - k \text{ for drop hammers.}$$

$$(2) \quad s = \frac{3.6 Wh}{R} \times \frac{W}{W+P} - k \text{ for single-acting ham-} \\ \text{mers.}$$

$$(3) \quad s = \frac{4 F}{R} \times \frac{W}{W+P} - k \text{ for double-acting hammers.}$$

A negative value of (s) indicates that a heavier hammer must be used.

(i) The data used in determining driving resistance

shall be obtained during the driving and not upon redriving when a pile has been allowed to stand more than one hour after having been driven. When driving wooden piles, broomed heads shall be cut to sound wood before making penetration measurements.

(j) For cast-in-place concrete piles in which the driven casing is withdrawn leaving a shell pile of smaller diameter than the outer casing, the pile driving formula may be used for piles in soils of Classes 11 and 12 and it may also be used for piles driven into soils of other classes when the supporting capacity obtained from the formula is at least doubled in the last three feet of driving.

(k) The commissioner shall require a competent inspector, qualified by experience and training and satisfactory to him, to be on the work at all times while piles are being driven. The inspector shall make an accurate record of the material and the principal dimensions of each pile, of the weight and fall of the hammer, if a single-acting steam hammer or drop hammer, and the size and make, number of blows per minute, and energy per blow, if a double-acting steam hammer, together with the average penetration of each pile for at least the last five blows and the grades at tip and cut-off. A copy of these records shall be filed and kept in the office of the commissioner. Where piles are driven through soft soil to hard bearing material, providing high point resistance, the grades of all piles or pile shells previously driven shall be measured to detect uplift; and if uplift occurs in any pile or pile shell while other piles are being driven, such pile or pile shells shall be driven again to the required resistance.

**SECTION 2910. Wooden Piles.** — (a) Every wooden pile shall be in one piece, cut from a sound live tree, and free from defects which may materially impair its strength or durability. It shall be butt-cut above the ground swell, and shall have substantially uniform taper from butt to tip. Wooden piles shall measure at least six inches in smallest diameter at the tip, at least eleven inches in smallest diameter two feet from the butt and at least ten inches in smallest diameter at the cut-off, these measurements being taken under the bark. The axis of a wooden pile shall not deviate from a straight line more than one inch for each ten feet of length nor more than six inches. Square timber of approved quality may be used as piling, in which case the average cross-section shall be not less than the commercial ten by ten inch section.

(b) The load on wooden piles shall not exceed the allowable load specified in section twenty-nine hundred and nine and, for piles of the minimum dimensions specified in this section, shall not exceed twelve tons for spruce, Norway pine, and woods of similar strength, nor sixteen tons for oak, southern yellow pine, and woods of similar strength. These limits may be increased one ton for each inch by which the diameters at both cut-off and tip exceed the minima specified.

(c) Piles shall be cut to sound wood before capping is placed. The cut-off grade shall be determined by the commissioner so as to be below the probable permanent ground water level.

(d) The center-to-center spacing of wooden piles shall be not less than twenty-four inches nor less than twice the butt diameter.

SECTION 2911. *Precast Concrete Piles.* — (a) Precast concrete piles shall be designed, cast and cured to have the strength necessary for handling and for driving. The concrete shall be proportioned to have a compressive strength of at least three thousand pounds per square inch as specified in Part 26. No pile shall be handled or driven until it has cured sufficiently to develop the necessary strength as shown by standard test specimens made from the same batches of concrete. Each pile shall be cast in one piece.

(b) Precast concrete piles shall be reinforced, except as otherwise specified in this section, in the manner specified for columns in Part 26. The ratio of the area of the longitudinal reinforcement to the cross-sectional area of the pile at mid-length shall be not less than two per cent. For a length of four feet at both ends of the pile, lateral ties shall be spaced not over three inches center-to-center or an equivalent spiral shall be provided. Reinforcing steel shall be embedded in the concrete forming the body of the pile at least one and one half inches from any exposed surface and in piles exposed to sea water such coverage shall be at least three inches.

(c) The minimum spacing center-to-center of precast concrete piles shall be two and one half times the square root of the cross-sectional area at the butt.

(d) The load on a precast concrete pile shall not exceed the allowable load specified in section twenty-nine hundred and nine, and shall not exceed thirty tons for a pile of one hundred and sixty-nine square inches cross-sectional area. For piles of larger cross-

section, this limit of load may be increased in proportion to increase in area.

(e) When precast concrete piles are driven to or into bearing materials of Classes 1 to 5 inclusive, or through materials containing boulders, they shall have metal tips of approved design. The driving equipment shall be such as to avoid injury to the piles.

SECTION 2912. *Cast-in-Place Concrete Piles.* —

(a) Cast-in-place concrete piles shall be so made and placed as to insure the exclusion of all foreign matter and to secure a well-formed unit of full cross-section. In forming such piles, the concrete shall not be poured through water.

(b) The spacing of cast-in-place concrete piles shall be sufficient to insure the preservation of the full cross-section. The spacing center-to-center shall be not less than twice the average diameter of the embedded portion of the pile, nor less than thirty inches. When the center-to-center spacing is less than two and one quarter times the average diameter of the embedded portion of the pile, or less than thirty-six inches, no pile shall be filled with concrete until all adjacent piles within a radius of four and one half average pile diameters and not less than five feet have been driven to the required resistance.

(c) The load on a cast-in-place concrete pile shall not exceed the allowable load specified in section twenty-nine hundred and nine, and shall not exceed thirty tons for a conical pile having an eight-inch tip and an average diameter of eleven inches, for an uncased cylindrical pile having a diameter of sixteen

inches and for a cased cylindrical pile having an average diameter of fourteen inches. This allowable load may be increased for larger piles in proportion to the increase in pile area.

**SECTION 2913. *Concrete-Filled Cylindrical Steel Piles.*** — (a) Piles consisting of concrete-filled steel cylindrical shells filled after driving, shall have an inside diameter not less than ten inches and a shell thickness of at least three-eighths inch, except that ten-inch and twelve-inch piles may have a shell thickness of five-sixteenths inch. Splices of shells shall be of such material and design as to insure alignment of shells and transmission of the load. The ends of each section of the shell shall be perpendicular to its axis, and all bearing surfaces shall be smooth and true. The outside diameter of the pile shall be at least one fortieth of its length.

(b) After driving, the inside of the shell shall be carefully cleaned to the bottom and its direction and cross-section verified. The cross-sectional area shall not vary more than ten per cent from its original cross-section. Shells shall be filled with concrete having an ultimate strength of at least two thousand pounds per square inch. Concrete shall not be placed in water except with written approval of the commissioner after submission of detailed specifications for procedure.

(c) The center-to-center spacing of concrete-filled steel piles, when driven open-ended, shall be not less than the diameter of the shell plus ten inches, and not less than two feet. When driven with closed ends, the spacing shall be as provided in section

twenty-nine hundred and twelve for cast-in-place concrete piles.

(d) The load on a concrete-filled steel pile shall not exceed the safe load on the concrete at four hundred pounds per square inch plus that on the steel shell at six thousand pounds per square inch, after deducting one eighth inch in thickness from the outside of the tube; nor shall the load carried by the steel exceed one half of the total load on the pile. If a pile as actually driven is longer than forty diameters, the limit of load specified in this paragraph shall be reduced by a percentage equal to the excess length divided by the diameter. If splices below the upper section are closer than twenty feet, the safe load on the pile shall be reduced five per cent for each splice in excess of the number required for twenty-foot spacing.

(e) The load on a concrete-filled steel pile shall not exceed the allowable load determined in accordance with section twenty-nine hundred and nine. Where it is positively proven that the piles rest upon sound rock of known quality, the allowable bearing value of the rock, instead of the allowable load determined in accordance with section twenty-nine hundred and nine may limit the allowable load on the pile.

(f) When a single concrete filled steel pile supports a detached column or pier, as provided in section twenty-nine hundred and eight, the load shall not exceed two thirds the capacity of the pile determined as provided in paragraphs (d) and (e) of this section.

SECTION 2914. *Composite Piles.* — (a) Composite piles shall consist of a combination of any two of the types of piles provided for in this part. The mini-

mum dimensions of each part shall be those specified for piles of its type. The allowable load shall be limited by the strength of the weaker type. The joint between the two types shall be constructed so as to prevent their separation, maintain alignment and support the load. The design of composite piles, method of driving and the details of the joint shall be subject to the commissioner's approval.

(b) The center-to-center spacing of composite piles consisting of a wood pile and a cast-in-place concrete pile shall be limited by the requirements of cast-in-place concrete piles.

SECTION 2915. *Foundation Load Tests.*—(a) Whenever the allowable load on a bearing material or on a pile is in doubt, the commissioner may require tests to be made to enable him to determine such load, as, in his opinion, will not cause dangerous or objectionable settlements. The load so determined shall be taken as the allowable load.

(b) The proposed testing apparatus and specifications of the procedure must receive the approval of the commissioner before it is used. Loads shall be applied by direct weight or by means of hydraulic jack pressure that is automatically maintained constant. Tests shall be made under the supervision of the commissioner. Settlement readings shall be referred to a bench mark established at a sufficient distance from the test to be unaffected by it and they shall be made by a method which assures accuracy to the degree hereinafter specified.

SECTION 2916. *Load Tests of Bearing Materials.*  
—(a) For bearing materials of Classes 1 to 5 inclu-

sive, the loaded area shall be at least one square foot and for other classes at least four square feet. For materials of Classes 6 to 13 inclusive, the loaded area shall be the full size of the pit and at such depth that the ratio of the width of the loaded area to its depth below the immediately adjacent ground surface is the same as the larger of the following two values:

(1) Ratio of the width of any footing to its depth below the immediately adjacent ground surface.

(2) Ratio of the width of the entire foundation or group of footings to its depth below the average surrounding ground surface.

(b) When loading tests are made on bearing materials of Classes 10 to 13 inclusive, suitable methods shall be used to prevent evaporation from the materials being tested.

(c) A test load shall be applied which will produce a unit pressure equal to that for which the proposed foundations are designed. This load shall be allowed to remain undisturbed until no measurable settlement occurs during a period of twenty-four hours. The load shall then be doubled in increments not exceeding twenty-five per cent of the design load. At least four hours shall elapse between the application of successive increments. The total load shall be allowed to remain undisturbed until no measurable settlement occurs during a period of twenty-four hours.

(d) Measurements of settlement shall be accurate to one thirty-second inch and shall be taken and recorded every hour during the first six hours after the application of each increment, and at least once every twelve hours thereafter.

(e) When the design load upon bearing materials

of Classes 1 to 10 inclusive causes settlement of less than three eighths inch and twice the design load causes settlement of less than one inch, the design load shall be allowed; but if medium or soft clay underlies these materials the vertical pressure in such clay shall not exceed that allowed in section twenty-nine hundred and four.

(f) Whenever the proposed foundation rests on or is underlain by bearing materials of Classes 11 to 13, inclusive, the results of loading tests must be interpreted in conjunction with accurate soil profiles showing magnitude and variation of the thickness of these strata. If this information, in the opinion of the commissioner, is not sufficient to determine whether the design load will cause excessive settlement, as might occur due to a thick stratum of clay, or dangerous differential settlement, as might occur when the underlying clay stratum varies considerably in thickness, the commissioner may require an analysis to be made of the probable magnitude, rate and distribution of settlement of the proposed structure. Such analysis may be based upon:

- (1) A study of settlement records of nearby structures having essentially the same foundation conditions.
- (2) Consolidation tests and other investigations of undisturbed samples of the compressible materials.

SECTION 2917. *Pile Loading Tests.* — (a) A pile to be tested shall be loaded to at least twice the proposed working load, the load being applied in increments of not over ten thousand pounds. At least four hours shall elapse between the addition of successive increments. Measurements of the settlement,

accurate to one thirty-second inch shall be taken and recorded immediately before and after each increment of load is added. In determining the settlement, proper deduction shall be made for elastic compression of the pile under the test load.

(b) The allowable pile load shall not exceed one half of that causing a total settlement of one half inch which remains constant for forty-eight hours, but the load on the bearing materials at the level of the points or upon any lower stratum shall not exceed the bearing values specified in sections twenty-nine hundred and four and twenty-nine hundred and nine.

## PART 30.

### FIRE EXTINGUISHING APPARATUS.

#### SECTION

- 3001 — Fire Extinguishing Apparatus Required.
- 3002 — Fire Department Standpipes.
- 3003 — First Aid Standpipes.
- 3004 — Piping for Standpipes.
- 3005 — Automatic Sprinklers.
- 3006 — Sprinkler Control.
- 3007 — Water Supply for Fire Extinguishing.
- 3008 — Portable Fire Extinguishers.
- 3009 — Inspection and Tests of Fire Extinguishing Apparatus.

SECTION 3001. *Fire Extinguishing Apparatus Required.* — (a) The owner of a building in which fire extinguishing apparatus is to be installed, altered or repaired (except repair of leaks and other minor repairs) pursuant to the requirements of this part, or connected to the water supply of the city of Boston, shall first make application to the building commissioner and obtain a permit therefor, in the manner specified in section ten of Part 1 and following sections relating to permits.

(b) Fire extinguishing apparatus shall be installed in buildings where specified in Parts 3 to 12, inclusive.

(c) Such fire extinguishing apparatus shall conform to the requirements of this part and to such additional requirements as are specified in Parts 3 to 12, inclusive.

SECTION 3002. *Fire Department Standpipes.* — (a) A fire department standpipe shall consist of a vertical pipe with fire department connection and outlet valves with connections for hose at convenient points in a building, by means of which the fire department may distribute water through the building to hose to be attached by the fire department for extinguishing a fire and protection against fire in an adjoining building.

(b) Fire department standpipes, where required, shall be of such number and so located that a stream from a nozzle on not more than one hundred feet of hose connected to a standpipe can be played upon every part of each story, assuming the stream to reach fifty feet from the nozzle.

(c) Fire department standpipes shall be not less than five inches in internal diameter throughout, and in buildings higher than ninety feet, or where the standpipe has a roof outlet, not less than six inches.

(d) Every fire department standpipe shall extend to every story of the building and above the roof unless the requirement of a roof outlet is waived by the commissioner. Such standpipe shall be located in a stair enclosure or other approved location and shall have, in every story above the first, an outlet two and one half inches in inside diameter threaded for standard fire hose coupling, and an approved

angle globe valve. The outlet above the roof shall have two such hose connections, each with a valve. Hose outlets shall be not more than five feet above the floor, roof or stair landing. Neither the standpipe, outlet nor valve shall project within the width required for a stairway as an exit. Convenient to every roof outlet shall be provided and properly stored not less than fifty feet of approved two and one half inch linen hose and a tapered nozzle with one and one eighth inch smooth orifice.

(e) Every fire department standpipe shall have a fire department connection in an exterior wall of the building, fronting on a street, in an approved location not less than ten inches nor more than forty-eight inches above the sidewalk or ground. Two or more standpipes may have a common fire department connection. Where a building is required to have two or more fire department standpipes and faces on two streets it shall have two fire department connections remote from one another. The fire department connection shall be of approved design, shall have two couplings and if it serves two or more standpipes, shall have three couplings of not less than two and one half inches inside diameter threaded to receive standard city of Boston fire hose, and protected by approved caps.

(f) Where a building contains two or more fire department standpipes and two or more fire department connections, they shall be cross connected, but the commissioner may waive this requirement subject to such conditions as he may in any case specify. Each fire department standpipe connection shall be marked by a cast bronze or brass plate embossed to indicate its connection to a standpipe.

(g) A fire department standpipe shall be connected to an adequate source of water supply and if subject to freezing shall be equipped with an approved control valve. An approved check valve shall be installed in the water supply pipe which will prevent water from the fire department connection from backing up in the supply pipes, and a check valve and automatic drain shall be installed between the standpipe and the fire department connection to prevent water from reaching a point where it would freeze.

(h) For protection against fire during construction, in a building required to have one or more fire department standpipes, they shall be installed with fire department connection and extended upward with the building, always reaching within one story of the highest constructed floor. During construction of the building, such standpipes shall be connected to an approved source of water supply and the outlets thereof shall be provided with hose and nozzles as required by the commissioner. Water shall be kept turned on in such standpipes during construction except in freezing weather and when the pipe is being extended. The shut-off valve shall be accessible and the standpipes in readiness for use at all times.

SECTION 3003. *First Aid Standpipes.* — (a) A first aid standpipe shall consist of a pipe or system of pipes connected to an adequate source of water supply, with valves, hose connections, hose and nozzles at convenient points inside the building for use of the occupants in extinguishing a fire.

(b) Where first aid standpipes are required they shall have hose stations in every story in such number and so located that a stream from a nozzle on the length of hose connected to an outlet can be played on every part of the story required to have such protection, assuming the stream to reach twenty feet from the nozzle. Pipes shall be so located as to be safe from injury by frost or otherwise.

(c) The risers of first aid standpipes shall be not less than two and one half inches internal diameter. Branches to single hose stations shall be not less than one and one half inches.

(d) A first aid hose station shall consist of an angle globe valve, threaded hose coupling, not more than fifty feet of approved linen hose, all one and one quarter inches in diameter, and a tapered nozzle with one half inch smooth orifice, attached, ready for use and mounted in an approved rack or reel, preferably in a cabinet. The valve and hose shall be not over five feet above the floor.

(e) First aid hose stations shall be located in corridors or other approved locations and shall be visible and accessible at all times.

(f) A fire department standpipe may serve as piping for a first aid standpipe if it is connected to an adequate water supply as provided in section thirty hundred and two but there shall be no interference between first aid hose stations and fire department outlets.

SECTION 3004. *Piping for Standpipes.* — (a) Pipe for fire department or first aid standpipes shall be of wrought iron or steel of standard weight except that extra heavy pipe and fittings shall be used

where the normal water pressure may exceed one hundred and seventy-five pounds per square inch.

(b) Piping shall be connected by screw fittings, flanges or unions; right and left fittings shall not be used. Fittings for changes in direction in pipes more than two inches in diameter shall be standard long turn fittings. Reduction in pipe size shall be made by reducing fittings.

SECTION 3005. *Automatic Sprinklers.* — (a) Where automatic sprinklers are required, the system of sprinklers and piping shall be designed to spray walls, ceilings and every portion of the floor space in accordance with the requirements of this part, except that arrangement and placement of sprinklers in accordance with the requirements of the National Board of Fire Underwriters for Class A system shall be accepted as meeting the requirements of this section.

(b) Where ceilings are smooth and unbroken there shall be a sprinkler for approximately every one hundred square feet and the spacing in a line shall not exceed twelve feet.

(c) Where ceilings are of wooden joist construction the spacing of sprinklers shall not exceed eight feet at right angles to the joists nor ten feet parallel to the joists and sprinklers shall be staggered at third points of the spacing in lines at right angles to the joists.

(d) Where ceilings have beams not less than five nor more than twelve feet apart on centers, sprinklers shall be placed midway between beams not over twelve feet apart and with not more than one hundred square feet of ceiling for each sprinkler.

(e) Sprinklers shall be placed under all soffits, inclined surfaces, decks, tables, benches, shelving, mezzanines, balconies or other similar construction, fixed, more than forty-two inches wide, within floor areas where sprinklers are required.

(f) Sprinklers shall not be placed closer than twelve inches from posts, walls, hangers or other vertical construction. Sprinklers, where required, shall be placed not further from walls and partitions than half the allowed spacing in the given direction, and under a joisted ceiling, not more than two feet.

(g) Sprinklers shall be placed preferably upright and the deflector shall be not more than ten inches nor less than three inches from the ceiling or soffit to be sprayed, the stream from the orifice perpendicular thereto.

(h) Sprinklers shall be of a type and construction approved by the commissioner, and designed to release at a temperature not more than one hundred degrees Fahrenheit above the normal temperature where they are installed.

(i) Pipe for sprinkler systems shall be of wrought iron or steel, of standard weight and size, or other approved pipe, and shall have not less than the following inside diameters, depending on the number of sprinklers within one story and fire division supplied through each section of pipe.

### *Minimum Pipe Sizes for Automatic Sprinklers.*

(j) In buildings of Type I and Type II construction, the commissioner may allow not more than two hundred and fifty sprinklers to be supplied through a six-inch pipe and not more than five hundred sprinklers through an eight-inch pipe, in one story and fire division.

(k) Piping shall be connected by screw fittings, flanges, or unions; right and left fittings shall not be used. Fittings for changes in direction in mains and risers more than two inches in diameter shall be standard long turn fittings. Reduction in pipe size shall be made by reducing fittings.

(l) The system of sprinkler piping shall be well supported and pitched to drain completely. Piping and equipment shall be safe from injury by frost or otherwise.

(m) Sprinkler systems or portions thereof subject to freezing shall be equipped with approved dry pipe valves or filled with approved non-freezing fluid. The commissioner may allow part of an automatic

sprinkler system to be controlled by a cold weather valve or other device subject to such conditions as he shall in any case specify.

**SECTION 3006. *Sprinkler Control.***—(a) The main supply pipe of a sprinkler system and each connection to the service main, if more than one, shall have a gate valve of approved indicator pattern with bronze stem, a check valve, test pipe and pressure gage, installed in approved locations. The main supply pipe of the system shall have a visible flow test pipe not less than one and one half inches in diameter with approved discharge. Valve stems shall not be placed below the horizontal and shall be within seventy-eight inches from the floor or shall be made accessible by permanent ladders fixed in place, or other approved means. Where sprinklers in two or more fire divisions are supplied through one or a set of two or more service connections, each fire division shall have a separate branch supply pipe with control valve and drain. Every required sprinkler system shall have a fire department connection, except that the commissioner may waive this requirement, subject to such conditions as he may specify, where the protected space is visible and directly accessible from a street or alley or where the number of sprinklers in any story and fire division does not exceed twenty-five.

(b) A fire department connection shall be of approved design and threaded for two and one half inch standard city of Boston fire hose and protected by approved caps. The pipe leading therefrom shall have a check valve and an automatic drain to prevent water from reaching a point where it would freeze.

(c) Every fire department sprinkler connection shall be marked with a cast bronze or brass plate embossed to indicate its connection to sprinklers.

(d) Every system of automatic sprinklers shall be connected to a permanent and adequate water supply as provided in section thirty hundred and seven.

(e) An inspector's test valve shall be installed at the top of every automatic sprinkler system.

(f) First aid hose stations, as specified in section thirty hundred and three, not more than two in a story, may be connected to the piping of an automatic sprinkler system if the size of the pipe is at least two and one half inches.

(g) Where a main supply pipe serves automatic sprinklers in a basement or sub-basement concealed from view, or a remote building or part of a building, an approved alarm shall be provided unless the commissioner shall waive this requirement.

(h) Neither goods, furniture, machinery or other materials or equipment shall be so placed as to interfere with the effectiveness of sprinklers nor shall sprinkler piping be used to support such materials or equipment.

SECTION 3007. *Water Supply for Fire Extinguishing.* — (a) Water supply for required fire extinguishing apparatus shall be taken from the "high service" city water mains where available and, except where pumped, shall be independent of the supply for sanitary, industrial or other purposes.

(b) In buildings where first aid standpipes or automatic sprinklers are required and where the city water supply, with a sufficient flow properly to supply the sprinklers will not furnish a pressure of

at least thirty-five pounds per square inch at the highest first aid hose station, and twelve pounds per square inch at the highest sprinkler, an auxiliary water supply for fire extinguishing apparatus shall be provided.

(c) An auxiliary water supply for fire extinguishing apparatus shall consist of a storage tank or a fire pump or both. A storage tank shall be either gravity or approved pressure type.

(d) A gravity storage tank shall have a capacity not less than five thousand gallons of water and the bottom of the tank shall be not less than twenty feet above the highest sprinkler or hose outlet. The tank and connected pipes shall have protection from freezing.

(e) A pneumatic pressure storage tank of such capacity (not less than thirty-five hundred gallons of water) and design, and with such automatic pumping equipment as will furnish as much water, at the same pressure, at the upper outlets of the system, as the gravity storage tank specified in paragraph (d) of this section, may be substituted therefor with the approval of the commissioner.

(f) A fire pump, to serve as an auxiliary water supply, shall be automatically controlled, shall be connected to the city mains and shall be capable of delivering water at the rate of twenty gallons per minute for each sprinkler up to fifty in any one story and fire division, against a head sufficient to furnish a pressure of twelve pounds per square inch at the highest sprinklers and of thirty-five pounds per square inch at the highest outlets of connected standpipes in the building and shall be of a type satisfactory to the commissioner. A fire pump shall be

connected to a permanent, reliable and approved source of power.

(g) Auxiliary water supply equipment shall have all necessary approved gate and check valves. Motors and other electrical equipment shall be enclosed, or protected by a hood and by a grille or partition of incombustible material.

SECTION 3008. *Portable Fire Extinguishers.* —

(a) A portable fire extinguisher shall consist of a container holding not less than two and one half gallons of extinguishing liquid so arranged and equipped that pressure may be generated and the contents discharged through a hose and nozzle; or a portable extinguisher of other type approved as equal thereto by the fire commissioner. The design and construction of portable fire extinguishers shall be approved by the fire commissioner.

(b) Portable fire extinguishers, where required, shall be mounted in corridors or other approved locations generally visible to the occupants of the building. Where they are placed in cabinets they shall be visible and the doors shall be unlocked or of glass which can be broken to give access to the extinguisher in case of fire.

(c) Portable fire extinguishers shall be discharged and recharged as often as shall be generally required by the fire commissioner for extinguishers of each type, and shall be recharged at once after use.

SECTION 3009. *Inspection and Tests of Fire-Extinguishing Apparatus.* — (a) Every system of automatic sprinklers and all parts thereof shall satisfactorily meet a pressure test of one hundred and fifty pounds per square inch.

(b) Standpipes and all parts thereof except hose shall satisfactorily meet a pressure test of two hundred and fifty pounds per square inch at ground level. Piping shall not be concealed until tested and approved.

(c) First aid hose and other hose required for extinguishing purposes shall satisfactorily meet a pressure test, unless this requirement is waived by the building commissioner, in his presence, when first installed, and shall be thoroughly dried before it is hung in racks or reels.

(d) All required fire extinguishing apparatus, except as provided in section three thousand and eight, shall be inspected at least once each year and such tests shall be made as the building commissioner shall require. Defective hose and other defective parts shall be replaced without delay on order of the building commissioner.

## PART 31.

### PLUMBING.

#### SECTION

- 3101 — Plumbing in Buildings.
- 3102 — Definitions pertaining to Plumbing.
- 3103 — The Drainage System.
- 3104 — Soil and Waste Pipes.
- 3105 — Rain Water Drains.
- 3106 — Indirect Wastes.
- 3107 — Sub-Sewer Drainage.
- 3108 — Traps.
- 3109 — Venting.
- 3110 — Vent Pipes.
- 3111 — Materials of Drainage System.
- 3112 — Water Supply.
- 3113 — Hot Water Supply.
- 3114 — Plumbing Fixtures and Units.
- 3115 — Cast Iron Pipes.
- 3116 — Wrought Iron and Steel Pipes.
- 3117 — Brass, Copper and Lead Pipes.
- 3118 — Inspection and Tests.

SECTION 3101. *Plumbing in Buildings.*—(a) Every building used for habitation or for human occupancy and every apartment in buildings of Group I, Division 1, shall have a supply of pure and wholesome water.

(b) Every building shall have such toilet accommodations and plumbing fixtures as are specified in Parts 3 to 12 inclusive of this code.

(c) Plumbing fixtures shall not be installed in rooms which do not conform to the requirements of this code for rooms to contain such fixtures.

(d) A permit to install, alter or repair plumbing shall not be issued unless the work is to be performed by a registered or licensed master plumber, registered by the commissioner, or a registered or licensed journeyman plumber employed by such master plumber, under chapter one hundred and forty-two of the General Laws. An application for a permit for plumbing shall be signed as provided in section one hundred and ten of this code by a registered master plumber.

(e) Every master plumber holding a certificate of registration issued in accordance with section three of chapter five hundred and thirty-six of the acts of nineteen hundred and nine, section two of chapter five hundred and ninety-seven of the acts of nineteen hundred and ten or chapter five hundred and eighteen of the acts of nineteen hundred and twelve, or licensed under chapter one hundred and forty-two of the General Laws, and who has a business address in Boston or does business in Boston, shall personally register his name and business address with the commissioner each year on or before the fifteenth day of May. He shall give the commissioner

immediate notice of any change in his business address.

**SECTION 3102. *Definitions Pertaining to Plumbing.***— For the purpose of this part of the code the words and terms defined in this section shall be construed as so defined except when qualifying words or the context clearly indicate that another meaning is intended.

**Battery of Fixtures;** a group of fixtures of one type, at the same level, not less than three in number.

**Branch;** that part of a system of piping which extends horizontally or at a slight grade from the main to a fixture or fixtures and which serves to connect to the main the fixtures which are not directly connected thereto.

**Certificate;** a certificate of registration issued in accordance with section three of chapter five hundred and thirty-six of the acts of nineteen hundred and nine, section two of chapter five hundred and ninety-seven of the acts of nineteen hundred and ten or chapter five hundred and eighteen of the acts of nineteen hundred and twelve.

**House Drain;** that part of the lowest horizontal piping of a building's drainage system which receives the discharge from soil, waste and other drainage pipes inside the walls and conveys it ten feet outside the inner face of the exterior walls.

**Indirect Waste Pipe;** a waste pipe which is not directly connected to the drainage system but discharges into an open sink or other fixture.

**Journeyman Plumber;** a person who himself does any work in plumbing subject to inspection under any law, ordinance, by-law, rule or regulation.

Length of Pipe; the developed length of pipe and fittings as connected, measured along the center line.

Main; a general term signifying the principal line of a system of piping from which branches extend to fixtures.

Master Plumber; a plumber having a regular place of business and who, by himself or journeyman plumbers in his employ, performs plumbing work.

Plumbing; the art of installing, repairing or altering the pipes, fixtures or other apparatus for distributing the water supply and removing liquid and water-carried wastes; also, the system of pipes, fixtures, and other apparatus installed in buildings for distributing the water supply and for the disposal of liquid and water-carried wastes, including valves, traps and soil, waste and vent pipes.

Plumbing Fixture; a receptacle connected to a waste or soil pipe for receiving and disposal of liquid or water-carried wastes.

Repair of Leaks; such repairs as are necessary to protect property but do not involve extensive change in construction.

Size of Pipe; its internal diameter or bore. (Does not apply to tubing.)

Soil Pipe; a pipe which conveys the discharge of water-closets, with or without the discharge of other fixtures, to the house drain.

Stack; a general term for a vertical line of soil, waste or vent piping.

Trap; a fitting or device so constructed as to prevent the passage of air or gas through a pipe without materially affecting the flow through it of sewage or waste water.

Trap Seal; the vertical distance between the crown weir and the invert of the trap outlet.

Vent Pipe; a pipe provided to ventilate a drainage system and to prevent back pressure and trap siphonage.

Waste Pipe; a pipe which receives the discharge of any plumbing fixture except a water-closet, and conveys it to the house drain or to a soil pipe.

Water Distribution Pipe; a pipe which conveys water from the service pipe to a faucet valve or plumbing fixture.

Water Service Pipe; the water supply pipe from the city main to the building served.

SECTION 3103. *The Drainage System.* — (a) The entire drainage system shall be so designed, constructed and maintained as to dispose of sewage and liquid wastes with velocities of flow that will avoid the deposit of solids and prevent clogging the pipes. The drainage pipes shall be so designed, constructed and supported as to be free from leakage of water, air or gas through defective materials, imperfect connections, corrosion, settlement, vibration, temperature changes, freezing or other causes. The entire system shall drain completely.

(b) The plumbing of every building shall be separately and independently connected, outside of the building, to the public sewer if such sewer is accessible, to an approved private sewer or, if a sewer is not accessible, to an approved cesspool; except that two or more buildings may have a common sewer if approved by the building commissioner and the commissioner of public works. Sewage discharged into a cesspool shall have such treatment

as the commissioner and the health commissioner shall require.

(c) No substances which will clog the drains, produce explosive mixtures or injure the pipes or their joints shall be allowed to enter the drainage system or the sewer.

(d) Steam, vapor, and water at a temperature above one hundred and thirty degrees Fahrenheit shall not be discharged into the sewer. The blow-off of boilers, steam exhaust or drip, or hot water from any other source destined to be discharged into a sewer shall first be condensed and cooled to one hundred and thirty degrees Fahrenheit in a blow-off tank or other approved device of which the size, arrangement, location, venting and all connections shall be subject to the approval of the commissioner and the commissioner of public works.

(e) A blow-off tank connected to one or more high pressure steam boilers shall have a capacity not less than thirty per cent of the largest boiler to which it is connected. Every blow-off tank shall have a vapor pipe not less than two inches in size extending above the roof and above any window within fifteen feet.

(f) Where a drainage system may be subjected to back flow of sewage suitable provision shall be made, by means of a gate or check valve or otherwise, to prevent its overflow in the building.

(g) No cement joints nor connections to cement or tile pipe or to a brick drain shall be made within a building.

(h) The house drain shall have a Y-branch fitted with a brass cleanout or with an iron stopper near the point where it leaves the building. If required by the commissioner the cleanout shall be in a straight

line with the drain as it passes through the wall. The drainage system shall have an adequate number of cleanouts so arranged that any stoppage in the pipes can be readily cleared. Cleanouts in drains underground shall be made accessible by means of approved manholes or pits. Other cleanouts shall be so located as to be accessible or to be made accessible through removable panels or otherwise.

(i) A house drain shall not be smaller in any portion than the largest soil or waste pipe or stack served by that portion.

(j) A house drain shall have a fall not less than one eighth inch per foot of run and its size shall not be less than required for the fixtures which discharge through it as provided in the following table. The number of fixture units assigned to each type of fixture is specified in section thirty-one hundred and fourteen.

*Maximum Number of Fixture Units for Pipe Size.*

PIPE LINE (INCHES).	$\frac{1}{8}$ -Inch Fall per Foot.	$\frac{1}{4}$ -Inch Fall per Foot.	$\frac{1}{2}$ -Inch Fall per Foot.
1 $\frac{1}{4}$ . . . . . . .	1	1	1
1 $\frac{1}{2}$ . . . . . . .	2	2.5	3.5
2 . . . . . . .	7	9	12
2 $\frac{1}{2}$ . . . . . . .	17	21	27
3 $^1$ . . . . . . .	33	45	72
4 . . . . . . .	114	150	210
5 . . . . . . .	270	370	540
6 . . . . . . .	510	720	1050
8 . . . . . . .	1290	1860	2640
10 . . . . . . .	2520	3600	5250
12 . . . . . . .	4390	6300	9300
15 . . . . . . .	8300	11600	16800

<sup>1</sup> No water closets.

(k) Changes in direction of house drains shall be made with curved pipes. Connections with branches, soil pipes, waste pipes or stacks shall be made with Y-branches.

SECTION 3104. *Soil and Waste Pipes.* — (a) Soil and waste pipes from plumbing fixtures shall discharge into the house drain.

(b) Lateral branches of soil or waste pipes, if more than twenty feet long shall be extended through the roof or connected to vent stack undiminished in size, except that a two-inch waste stack may be connected at the bottom to a three-inch waste if the number of connected fixture units does not exceed eight.

(c) A horizontal branch of soil or waste pipe shall have a fall not less than one eighth inch per foot of run. The size of such a branch which receives only the discharge of fixtures in the next story above the branch or higher, shall be as provided in section thirty-one hundred and three for the house drain.

(d) The size of a horizontal branch of soil or waste pipe which receives the discharge of fixtures in the same story with the branch shall be not less than is provided in the following table, depending upon the slope and the fixtures which discharge through the branch. The number of fixture units assigned to each type of fixture is specified in section thirty-one hundred and fourteen.

*Maximum Number of Fixture Units for Pipe Size.*

PIPE SIZE (INCHES).	$\frac{1}{8}$ -Inch Fall per Foot.	$\frac{1}{4}$ -Inch Fall per Foot.	$\frac{1}{2}$ -Inch Fall per Foot.
1 $\frac{1}{4}$ . . . . . . .	1	1	1
1 $\frac{1}{2}$ . . . . . . .	2	2	3
2 . . . . . . .	5	6	8
2 $\frac{1}{2}$ . . . . . . .	12	15	18
3 . . . . . . .	24	27	36
4 . . . . . . .	84	96	114
5 . . . . . . .	180	234	280
6 . . . . . . .	330	440	580
8 . . . . . . .	870	1150	1680
10 . . . . . . .	1740	2500	3600
12 . . . . . . .	3000	4200	6500
15 . . . . . . .	6000	8500	13500

(e) No soil pipe shall be less than four inches in size, except that a three-inch soil pipe may be used for one water closet, with the approval of the commissioner, where it is not practicable to use a four-inch pipe.

(f) No waste pipe where buried underground shall be less than three inches in size.

(g) In buildings more than one hundred and twenty-five feet high, soil pipe shall be at least five inches, waste pipes serving slop sinks shall be at least four inches and waste pipes serving lavatories or urinals shall be at least three inches in size.

(h) Main soil and waste pipes shall have approved T-Y or Y fittings for branch connections.

SECTION 3105. *Rain Water Drains.* — (a) All rain water drains from roofs, excluding area drains and surface drains, shall be kept separate from the house drainage system of a building, except as provided in

this section. Area drains and surface drains shall be connected to the house drainage system or otherwise disposed of with the approval of the commissioner.

(b) Where a storm water sewer is accessible rain water drainage shall be discharged therein. Elsewhere the main rain water drain shall extend at least ten feet from the inner face of the foundation wall.

(c) A main rain water drain outside a building, except where a storm water sewer exists, shall be laid not lower than four feet below ground.

(d) Rain water leaders shall not project into a public way more than seven inches.

(e) A rain water drain shall have a fall not less than one eighth inch per foot of run. The size of a rain water drain shall be not less than as provided in the following table.

*Maximum Horizontal Projection of Drained Area.*

PIPE SIZE (INCHES).	$\frac{1}{8}$ -Inch Fall per Foot (Square Foot).	$\frac{1}{4}$ -Inch Fall per Foot (Square Foot).	$\frac{1}{2}$ -Inch Fall per Foot (Square Foot).
2 . . . . . . . .	300	440	620
2 $\frac{1}{2}$ . . . . . . . .	545	790	1100
3 . . . . . . . .	865	1250	1750
4 . . . . . . . .	1860	2650	3800
5 . . . . . . . .	3800	4700	6650
6 . . . . . . . .	5250	7500	10700
8 . . . . . . . .	11000	16000	22200
10 . . . . . . . .	19500	27500	40000
12 . . . . . . . .	32500	45500	65500

A vertical rain water stack or leader shall have at least the size required for a fall of one half inch per foot.

SECTION 3106. *Indirect Wastes.* — (a) Drips, overflow pipes from open tanks or from refrigerators, ice boxes or other containers in which food is stored, or from sterilizers in hospitals, distilled water equipment, vacuum and compressed air equipment in operating rooms, shall be indirect wastes, shall not be directly connected to soil or waste pipes or any other part of the drainage system, but such wastes, unless otherwise disposed of, shall be discharged in open sight into a sink, floor drain, funnel or other fixture which shall, if required by the commissioner, have a supply of water for maintaining the water seal in the trap.

(b) Indirect waste pipes shall have traps.

(c) The traps of indirect wastes serving one story in a building need not be vented, but an indirect waste stack serving two or more stories shall be extended through the roof independently of other stacks.

SECTION 3107. *Sub-Sewer Drainage.* — (a) Floor drains, drips from machinery and other clean wastes approved by the commissioner, too low to drain by gravity to the sewer, may drain to an open or closed sump or receiving tank and thence be discharged by mechanical means into the gravity drainage system. The discharge pipe shall be equipped with a check valve and shall be trapped and vented as herein provided for a waste pipe from a plumbing fixture.

(b) Where the whole or a part of a drainage system receiving the discharge of one or more plumbing fixtures, other than those provided for in the preceding paragraph, is too low to drain by gravity to the sewer it shall drain to a closed sump or receiving tank

and thence be discharged by mechanical means, automatically operated, into the gravity house drain or directly into the sewer. Such closed sump or receiving tank shall form part of the drainage system and shall be made tight and be tested as provided for other parts of the system. It shall be vented by means of an independent vent pipe not less than four inches in size extended through the roof as provided for vent stacks in section thirty-one hundred and ten, or connected to a vent stack not less than four inches in size at least twenty feet above the tank.

(c) The plumbing fixtures which drain to a closed sump or receiving tank for mechanical discharge shall have waste or soil pipes, traps and vent pipes as provided for gravity drainage except that the vent pipes from such pipes shall not be connected to vent pipes serving fixtures drained by gravity to the sewer. Such vent pipes shall be extended independently through the roof or be connected to a vent stack not less than twenty feet above the tank.

(d) Drainage discharged by mechanical means into the gravity drainage system within a building, as provided in this section, shall enter the house drain near the point where it leaves the building.

(e) The discharge pipe from a sewage ejector shall not be less than four inches in size.

SECTION 3108. *Traps.* — (a) Except as otherwise provided in this section, the waste pipe of every plumbing fixture shall have a separate trap to prevent emission through the fixture of foul air from the drainage system. Such trap shall be placed as near the fixture which it serves as is practicable.

(b) A sink and set of not more than three laundry

trays, where the outlet from the sink is not more than three feet six inches from the nearest outlet from the laundry trays may have a common five-inch round trap. A combination sink and tray may have a two-inch half-S brass trap. Such traps shall be above the floor. The waste pipe from the tray or set of trays shall enter the trap separately from the waste from the sink.

(c) The waste pipe from a sink or dish washer in the kitchen of a hotel, restaurant or club shall have an approved grease trap easy of access to open and clean and placed as near as practicable to the fixture which it serves.

(d) The waste pipe from every floor drain or other fixture from which, in the opinion of the commissioner of public works, grease may be discharged in such quantity as to clog or injure the sewer, shall have an approved grease trap.

(e) The waste pipe from every floor drain or other fixture from which gasoline, naptha or other inflammable liquid may be discharged to a sewer shall have a special trap approved by the commissioner of public works so constructed as to prevent the passage of such liquids or gas into the sewer, with a separate vent pipe.

(f) The waste pipe from a wash stand for vehicles shall have an approved sand trap.

(g) The waste pipe from an area drain or surface drain shall have a deep seal trap.

(h) A main rain water drain which discharges into the sewer shall be trapped near the point where it leaves the building or enters the house drain.

(i) Every trap specified herein shall be a reliable,

self-scouring water-seal trap and shall be so located as to be accessible.

(j) Non-siphon traps and deep-seal traps shall have a water seal of at least four inches.

(k) Clean outs of traps shall be the full size of the trap up to four inches in diameter and not less than four inches for larger traps.

(l) Slip joints or unions may be used on the inlets but not on the outlets of traps.

(m) Threaded connections on brass traps shall fit the thread on the pipe and shall be tapered.

SECTION 3109. *Venting.*—(a) The drainage system shall be so designed that there will be circulation of air in all pipes thereof and no danger of siphonage, aspiration or forcing of trap seals under conditions of ordinary use.

(b) Traps, except non-siphon traps where approved, shall be protected from siphonage or air pressure by separate vent pipes, except as otherwise provided in this section.

(c) The traps for the fixtures having the highest connection to a soil or waste stack need not have separate vent pipes if within five feet from the stack and the soil or waste pipe is connected to the stack not more than eighteen inches below the invert of the trap outlet.

(d) The traps of a battery of water closets or other plumbing fixtures may have, instead of separate vent pipes, a vent pipe connected to the common waste or soil pipe just below the branch from the fixture most remote from the waste or soil stack, the full size of the common waste or soil pipe. If such a

battery has more than six fixtures there shall be similar vent pipe connection below the branch from every fifth fixture. The vent pipe fitting shall slope upward from the common waste or soil pipe at an angle not less than forty-five degrees with the horizontal. This type of venting may be used only where the common waste or soil pipe is not more than twenty-four inches below the waterline of the traps protected and where the length of the branch waste or soil pipe from the seal of the trap to the common waste or soil pipe is not more than three feet six inches. Where eight or more batteries of fixtures so vented are located above one another on the same stack, the fixture in each battery nearest the waste or soil stack shall have a separate vent pipe.

(e) Single floor drains shall be separately vented but groups of two or more floor drains discharging through branch waste pipes not more than fifteen feet long into a main waste pipe serving floor drains only may be vented by means of an extension of the main waste pipe undiminished in size as a vent pipe.

**SECTION 3110. *Vent Pipes.***—(a) The vent pipes from traps and from soil and waste pipes shall be extended upward through the roof or connected to vent stacks extended through the roof. Waste and soil stacks shall be extended through the roof and for the purpose of this section, the portion of a waste or soil stack above the highest fixture connected to it shall be considered a vent stack.

(b) Vent pipes shall be connected at the bottom with a soil or waste pipe or with the house drain in

such manner as to prevent accumulation of rust scale and properly to drip the water of condensation.

(c) Vent stacks shall be extended to a height of not less than two feet above the roof and not less than one foot above the top of any window within fifteen feet. Where a roof is to be used by persons, other than for making repairs, vent stacks shall extend not less than eight feet above the roof and the arrangement shall be subject to the approval of the commissioner.

(d) Vent stacks less than four inches shall be increased one inch in size from a point below the roof to the top.

(e) Two or more vent pipes may be connected together but such connection shall be above the fixtures served.

(f) Vent pipes shall not be connected to the trap or branched into the waste pipe except where a continuous vent is not practicable. Vent pipes shall be run as directly as practicable. Vent pipes for water-closet wastes shall be connected to the highest possible point of such wastes, and in no case more than eighteen inches below the trap seal.

(g) The size of a vent pipe shall not be less than as provided in the following table depending upon the number of fixture units which it serves and the length of the pipe.

PIPE SIZE (INCHES).	Maximum Number of Fixture Units.	Maximum Length (Feet).
1 $\frac{1}{4}$	1	20
1 $\frac{1}{2}$	6	25
2	40	60
2 $\frac{1}{2}$	72	100
3	120	150
4	250	250
5	500	300
6	1250	400
8	2400	Not limited

In determining the length of a vent pipe the stack and branches shall be considered continuous.

(h) A vent pipe serving water closets shall be not less than two inches. Such two-inch vent pipe shall not serve more than three water closets nor be longer than forty feet.

(i) Vent pipes shall be at least one and one quarter inches in size. Vent pipes from one and one half inch waste pipes shall be at least as large as the waste. The size of a vent stack shall be at least one half that of the waste or soil stack served.

(j) In buildings more than one hundred and twenty-five feet high;

1. Two-inch vent pipes serving water closets shall not be more than thirty feet long;

2. Three-inch vent stacks shall not extend above the eighth floor but shall be enlarged to at least four inches above the eighth floor.

3. Vent stacks shall not be connected with other vents or vent stacks but shall extend through the roof independently;

4. Vent pipes for slop sinks shall be proportioned as though they served water closets;

5. Vent stacks for lavatories or urinals shall be not less than three inches in size;

6. Vent stacks, including the upper portion of waste stacks, three inches or less in size shall be increased to four inches from a point below the roof to the top.

(k) Where three or more vent stacks are connected near the top to a single pipe extending through the roof, the internal area of the combined stack shall be not less than one half the sum of the areas of the stacks so connected.

**SECTION 3111. *Materials of Drainage System.* —**

(a) Waste, soil and vent pipes shall be of cast iron hub and spigot pipe, cast iron screw pipe, galvanized steel or wrought iron, lead, brass or copper, except that cast iron screw pipe, and galvanized steel or wrought iron pipe shall not be used underground and galvanized steel or wrought iron pipe shall not be used where concealed. So-called acid resisting hub and spigot cast metal pipe of the same dimensions as extra-heavy cast iron hub and spigot pipe, or other approved corrosion resisting pipe, may also be used for waste and vent pipes.

(b) The house drain and the main rain water drain for a distance of ten feet outside the inner face of the foundation wall shall be cast iron, hub and spigot pipe coated with asphaltum or red lead.

(c) Waste and vent pipes, traps and fittings serving fixtures in chemical laboratories or used for the disposal of acid or other corrosive chemicals shall be of approved acid resisting materials. The arrangement of piping shall be approved by the commissioner.

(d) Lead pipes may be used only for short connections exposed to view.

SECTION 3112. *Water Supply.* — (a) All water piping of every description supplying water from city mains for domestic purposes shall be installed by a plumber licensed under chapter one hundred and forty-two of the General Laws and after obtaining a permit.

(b) Water supplied from city mains shall be distributed by a system of piping independent of water from any other source unless it is approved by the health commissioner for drinking purposes.

(c) No connections to fixtures supplied with potable water, or to the supply piping thereof, shall be made from other pipes, piping systems, mechanical apparatus, equipment or device, directly or indirectly, in such manner that in the opinion of the health commissioner and the building commissioner the quality of the potable water may be adversely affected. No plumbing fixture, device or construction shall be installed which will provide a cross connection between a distributing system of water for drinking and domestic purposes and a drainage system, soil or waste pipe or sprinkler or process piping systems so as to permit or make possible the back flow of sewage or waste or non-potable water into the water supply either by gravity, siphonage or pressure.

(d) The water service pipe of every building shall be of sufficient size to permit continuous ample flow of water to fixtures in all stories at all times.

(e) Where the water pressure is insufficient to supply all fixtures freely and continuously a house

supply tank or pneumatic system shall be provided adequate for the purpose. Such tank or system shall be supplied by city pressure through ball cocks or, where necessary, by power-driven pumps.

(f) Gravity house supply tanks shall be of wood or steel, or of wood lined with lead or with tinned and planished copper and shall be properly supported. They shall be provided with suitable covers which shall be of metal if exposed to weather.

(g) Overflow pipes from gravity tanks shall discharge, when possible, above and within six inches of the roof, otherwise they shall be trapped and discharged over an open, water supplied sink three feet six inches or less above the floor. Connection of overflow pipes with any part of the plumbing, except as above provided, is prohibited. Overflow pipes shall be at least one commercial size larger than the supply pipe, with a minimum of four inches for tanks the capacity of which is five hundred gallons or over.

(h) All plumbing fixtures shall be provided with a sufficient supply of water for flushing to keep them in a sanitary condition. Every water closet or urinal shall be flushed by means of an approved flush valve or tank of at least four gallons flushing capacity for water closets and at least two gallons for urinals, and shall be adjusted to prevent the waste of water. The flush pipe for water closet flush tanks shall be not less than one and one quarter inches in diameter and the water from flush tanks shall be used for no other purpose.

(i) No fixture shall be supplied directly from a water supply system through a flushometer or other valve unless such valve is set above the fixture in a manner such as to prevent any possibility of polluting the water supply either by gravity or siphonage.

(j) A main shut-off shall be provided on the water service pipe between the building wall and the street main. An accessible shut-off shall be provided on the main water distribution pipe just inside the foundation wall which shall control the water supply to the entire building. In structures, other than residences occupied by one or two families, accessible shut-offs shall also be provided which shall separately control the water supply for each flat, apartment, suite, or store of a building, for each hose bibb, for each lawn sprinkler, for each hot water tank and for each water closet.

(k) All water supply pipes for a plumbing system shall be of lead, galvanized wrought iron or steel, brass or cast iron, with brass, or galvanized malleable iron fittings, or approved copper pipe and fittings. Cast iron pipe and fittings shall conform to American water works bell and spigot pipe specification. No pipe or fittings that have been used for other purposes shall be used for distributing potable water.

(l) Water supply branches of lead, copper or brass to individual fixtures shall be three eighths inch size; of other material, one half inch size. The minimum size of supply to a lavatory or a flush tank shall be three eighths inch; and to other fixtures except flush valves shall be one half inch. Water supply branches connected to flush valves shall be one inch size for water closets and three quarters inch for urinals.

SECTION 3113. *Hot Water Supply.* — (a) Hot water storage tanks shall be installed and connected by a licensed plumber.

(b) No hot water storage tank or other vessel in which water is to be stored or heated under pressure

shall be installed or connected to plumbing pipes unless it has been plainly stamped in the metal with the maker's name, the capacity, the pressure to which it has been tested and the maximum safe working pressure in accordance with the provisions of chapter two hundred and thirty-four of the acts of the Massachusetts general court in nineteen hundred and thirty-six.

(c) No such tank or other vessel shall be installed or connected where the pressure, whether from gravity house tank, from city water supply or otherwise may exceed the safe working pressure thereof.

(d) A hot water storage tank or other vessel in which water is to be stored or heated under pressure exceeding twenty pounds per square inch which is connected directly to the city water supply shall be equipped with approved temperature, pressure and vacuum relief valves or valve, connected close to the tank without intervening shut-offs. Temperature and pressure relief valves shall be piped with non-ferrous materials to discharge into an open fixture. The temperature relief device shall be on the top of the tank or on a hot water flow pipe not further than twelve inches from the tank.

(e) Pipe and fittings of ferrous composition shall not be permitted on branch supplying a hot water generating unit or on the hot water distributing piping of a plumbing system. Special materials for water supply purposes shall be submitted for approval to the commissioner.

SECTION 3114. *Plumbing Fixtures and Units.* —

(a) Fixtures in chemical laboratories or used for disposal of acid or other chemicals, shall be of materials

and installed in a manner approved by the commissioner.

(b) The orifice of the jet of every drinking fountain shall be placed above the rim of the fixture and shall throw an inclined stream. The water supply issuing from the orifice shall be of sufficient volume and height so that persons using the fountain need not come in direct contact with the fixture or orifice.

(c) Stable fixtures and their drainage piping shall be installed in a manner approved by the commissioner.

(d) Earthenware integral fixture traps shall have a flange on the fixture bolted to a flange on the end of the waste or soil pipe, the joint made tight with red or white lead or other approved compound, or with an approved gasket. A rubber gasket shall not be used. If the waste or soil pipe is of lead the flange on its end shall be of heavy brass soldered to the lead pipe; if of cast iron, the flange shall be of extra heavy cast iron calked or screwed to the pipe. Such floor flanges for water closets, slop sinks or urinals shall be not less than three sixteenths inch thick.

(e) No trough or multiple type urinal or water closet shall be installed except for exterior temporary use, unless approved by the commissioner.

(f) For determination of the sizes of traps and of waste, soil and vent pipes serving plumbing fixtures and groups of fixtures, in the three classifications of use herein defined, unit values are assigned to fixtures in the following table. The table also gives the minimum size of trap and of waste or soil pipe for a single fixture of each type.

Class 1 shall apply to fixtures in residences, apartments, private bathrooms of hotels and similar

installations intended for the use of a family or an individual.

Class 2 shall apply to fixtures in office buildings, factories, dormitories and similar installations intended for use of the occupants of the building.

Class 3 shall apply to fixtures in general toilet rooms of schools, gymnasiums, hotels and installations for similarly unrestricted use.

Unit ratings given in the table without class limitation shall apply to the fixture wherever installed.

	Class.	Trap and Drain Size (Inches).	Fixture Units.
Lavatory or wash basin . . . . .	1	1½	1
Lavatory or wash basin . . . . .	2, 3	1½	2
Water closet . . . . .	1	3	3
Water closet . . . . .	2	3	5
Water closet . . . . .	3	3	6
Bath tub . . . . .	1	1½	3
Bath tub . . . . .	2, 3	2	4
Shower stall, shower head only . . . . .	1	1½	2
Shower stall, shower head only . . . . .	2, 3	2	3
Shower stall, multiple spray . . . . .	1	2	4
Shower stall, multiple spray . . . . .	2, 3	3	6
Gang shower, for each head . . . . .	-	-	5
Urinal, stall or wall hung, tank or flush valve . . .	-	2	4
Urinal, pedestal or blow out . . . . .	-	3	5
Bathroom group of one lavatory, one water closet and either a shower stall or a bath tub with or without shower.	1	-	6
Bathroom group of one lavatory, one water closet, one bath tub and one shower stall, in one room.	1	-	7
Sink; kitchen, dishwasher, butler's or pantry sink . . .	1	1½	3
Glass or silver sink, in hotel or restaurant . . . . .	-	1½	3
Pot sink, in hotel or restaurant . . . . .	-	3	8
Vegetable sink in hotel or restaurant . . . . .	-	2	6
Bar sink, in lunch counter . . . . .	-	2	6
Bar sink, in soda fountain . . . . .	-	1½	1.5
Slop sink, ordinary . . . . .	-	2	3
Slop sink, siphon jet, flush rim or mop . . . . .	-	3	6
Sink; laboratory, surgeon's or medical . . . . .	-	1½	1.5

	Class.	Trap and Drain Size (Inches).	Fixture Units.
Bedpan sink, washer, or sterilizer . . . . .	-	3	6
Sterilizer; instrument, utensil or water . . . . .	-	1½	0.5
Laundry tray or combination fixture . . . . .	-	1½	3
Foot bath or sitz bath . . . . .	-	1½	2
Baby's slab bath . . . . .	-	1½	0.5
Drinking fountain, dental fountain or cuspidor .	-	1½	0.5
Floor drain, ordinary . . . . .	-	2	1
Floor drain, flush rim . . . . .	-	2	3
Floor drain, receiving overflows or unrated discharges, for each gallon per minute estimated maximum flow.	-	-	2
Sewage ejector, for each 25 gallons per minute dis- charge capacity.	-	-	50

**SECTION 3115. *Cast Iron Pipe.***—(a) Cast iron pipe shall be sound, cylindrical and smooth, free from cracks, sand holes and other defects, of uniform thickness and of the grade known in commerce as extra heavy. If buried underground it shall be coated with asphaltum or red lead; otherwise it shall be uncoated until inspected and approved. The weight of cast iron pipes per length, in lengths to lay five feet, shall not be less than listed in the following table:—

*Minimum Weights of Cast Iron Pipe.*

DIAMETER (INCHES).	WEIGHT PER LENGTH (POUNDS).	
	Single Hub.	Double Hub.
2 . . . . .	25	26
3 . . . . .	45	47
4 . . . . .	60	63
5 . . . . .	75	78
6 . . . . .	95	100
7 . . . . .	150	157
8 . . . . .	215	225
10 . . . . .	270	285
12 . . . . .	375	395

(b) Fittings for cast iron hub and spigot pipe shall be of the weight known in commerce as extra heavy.

(c) Joints in cast iron hub and spigot pipe shall be made with picked oakum and molten lead run full and calked to make gas tight.

(d) No double hub or sleeve shall be used on cast iron drain, waste, soil or vent pipes. The drilling, tapping or welding of cast iron, hub and spigot drain, waste, soil, or vent pipes, and the use of saddle hubs or bands are prohibited.

(e) Calking ferrules shall be of approved quality bell-shaped cast brass, not less than four inches long, nor less than two and one quarter inches in diameter, and weighing not less than the weight listed in the following table for four inches of length:

*Minimum Weights of Cast Brass Ferrules.*

DIAMETER (INCHES).	Weight (Ounces).
2 $\frac{1}{4}$ . . . . . . . . . . . . . . . . . .	16
3 $\frac{1}{2}$ . . . . . . . . . . . . . . . . . .	28
4 $\frac{1}{2}$ . . . . . . . . . . . . . . . . . .	40

(f) Clean outs in cast iron hub and spigot pipe shall have brass or cast iron bodies. Clean outs shall be the full size of the drain up to four inches and not less than four inches for larger drains. The caps shall be of cast brass not less than one eighth inch thick, shall have solid square or hexagonal nuts not less than one half inch high and one and one half inches in diameter, or recesses for special wrenches, and shall have not less than six tapered threads standard for iron pipe.

(g) Where steel or wrought iron pipe is connected to cast iron hub and spigot pipe the joint shall be made by means of a calking sleeve.

SECTION 3116. *Wrought Iron and Steel Pipe.*—  
(a) Galvanized wrought iron or galvanized steel pipe shall be of not less than the following thickness and weight per linear foot:—

SIZE.	DIAMETERS (INCHES).		Thickness (Inches).	WEIGHT PER FOOT (POUNDS). Plain Ends.
	External.	Internal.		
$\frac{5}{8}$	.675	.493	.081	0.567
$\frac{1}{2}$	.840	.622	.109	0.850
$\frac{3}{4}$	1.050	.824	.113	1.130
1	1.315	1.049	.133	1.678
$1\frac{1}{4}$	1.660	1.380	.140	2.272
$1\frac{1}{2}$	1.900	1.610	.145	2.717
2	2.375	2.067	.154	3.652
$2\frac{1}{2}$	2.875	2.469	.203	5.793
3	3.500	3.068	.216	7.575
$3\frac{1}{2}$	4.000	3.548	.226	9.109
4	4.500	4.026	.237	10.790
5	5.563	5.047	.258	14.617
6	6.625	6.065	.280	18.974
8	8.625	8.071	.277	24.696
8	8.625	7.981	.322	28.554
10	10.750	10.192	.279	31.201
10	10.750	10.136	.307	34.240
10	12.750	10.20	.365	40.483
12	12.750	12.090	.330	43.775
12	12.750	12.000	.375	49.562

(b) Close nipples shall be of the weight and thickness known as extra heavy, or extra strong.

(c) Fittings for wrought iron or steel soil, waste or drain piping shall be cast iron, recessed and

threaded drainage fittings, with smooth interior water-way and threads tapped so as to provide a uniform slope in branches from a vertical pipe of not less than one quarter inch per foot. Fittings for wrought iron or steel vent piping shall be cast pattern.

### SECTION 3117. *Brass, Copper and Lead Pipes.*—

(a) Brass and copper pipe for soil, waste and vent pipes shall be of the weight and thickness known in commerce as iron pipe size and shall have not less than the following thickness:—

(b) Fittings for brass or copper soil, waste, or drain pipes shall be recessed and threaded brass drainage fittings with smooth interior water-way and threads tapped so as to provide a uniform slope in branches from vertical pipes of not less than one quarter inch per foot.

(c) Lead pipes for soil and waste pipes including bends and traps, and for vent and flush pipes shall be not less than the following average thickness and weight per linear foot and not more than the following lengths.

SIZE (INCHES).								Thickness (Inches).	Weight per Linear Foot (Pounds).	Maximum Lengths (Feet).
1 $\frac{1}{4}$	.	.	.	.	.	.	.	.14	2.50	5
1 $\frac{1}{2}$	.	.	.	.	.	.	.	.14	2.68	5
2	.	.	.	.	.	.	.	.15	3.61	4
2 $\frac{1}{2}$	.	.	.	.	.	.	.	.20	5.72	-
3	.	.	.	.	.	.	.	.21	7.54	2
3 $\frac{1}{2}$	.	.	.	.	.	.	.	.22	9.00	-
4	.	.	.	.	.	.	.	.23	10.66	2
4 $\frac{1}{2}$	.	.	.	.	.	.	.	.24	12.34	-
5	.	.	.	.	.	.	.	.25	14.50	-
6	.	.	.	.	.	.	.	.28	18.76	-
7	.	.	.	.	.	.	.	.30	23.27	-
8	.	.	.	.	.	.	.	.32	28.18	-
9	.	.	.	.	.	.	.	.34	33.70	-
10	.	.	.	.	.	.	.	.36	40.06	-
12	.	.	.	.	.	.	.	.37	48.98	-

(d) The use of lead pipes in a drainage system is restricted to short branches of waste, soil and vent pipes, bends and traps, flush pipes, and roof connections of rain-water leaders.

(e) No connections shall be made to lead bend soil pipes of water closets or waste pipes of slop sinks except the required vent pipe connection where a continuous vent is not practicable.

(f) Branch connections of lead pipe shall be soldered and wiped full size; connection of lead pipe to cast iron and screw pipe shall be made by means of brass ferrules and soldering nipples respectively to which the lead pipe shall be soldered and wiped full size; other connection in lead pipe shall be made by means of a round or flanged joint soldered and wiped full size. Overcast or cup joints are prohibited.

(g) Soldering nipples for the connection of lead pipe to screw pipe shall be of approved quality cast

brass or of brass pipe, iron pipe size. If cast, they shall have not less than the weight listed in the following table:—

*Minimum Weights of Cast Brass Soldering Nipples.*

DIAMETER (INCHES).	Weight (Ounces).
1½	8
2	14
2½	22
3	32
4	56

SECTION 3118. *Inspection and Tests.* — (a) No part of a plumbing system shall be covered or concealed from view until it has been examined or tested and approved by the commissioner, who shall examine or test it within two working days after receiving written notice that the work is ready for inspection. No part of a plumbing system shall be used unless the waste, soil and vent pipes, when roughed in, and the water supply pipes, have been tested in the presence of and approved by the commissioner at a time when such testing is practicable.

(b) Tests shall be made by water or air pressure in such manner as to disclose all leaks and imperfections in the work.

## PART 32.

### VALIDITY.

SECTION 3201. The invalidity of any section or provision of this act shall not invalidate any other section or provision hereof.



2/29/88

